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VOL. CXLV.—No. 3774] LONDON: FRIDAY EVENING, MAY 11, 1928 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING, &c.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 24th May, 1928, for ACCELERATED LOW-PRESSURE HOT WATER HEATING and FIRE SERVICE at the Telephone Exchange, Shepherd's Bush, W.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender, may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea (cheques payable to the Commissioners, H.M. Office of Works). The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8475

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 29th May, 1928, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at (1) Primrose Hill, N.W., Telephone Exchange; (2) Ilford Post Office, &c.

Drawings, specifications, copies of the conditions and forms of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea in each case. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8435

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 25th May, 1928, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at the "Northern" Telephone Exchange, Birmingham.

Drawings, specification, a copy of the conditions and forms of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8439

The Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

SCHEDULE 1.—5 LOCOMOTIVE BOILERS (metre gauge).

SCHEDULE 2.—About 80 Tons of STEEL SCREWSPIKES.

SCHEDULE 3.—LATHES, SLIDING, SURFACING and SCREWCUTTING :—One 45in. centre; one 12½in. centre; and one 7in. Portable Boring Bar.

SCHEDULE 4.—22 LOCOMOTIVE ENGINES and TENDERS (metre gauge).

Tenders due on the 1st June, 1928, for Nos. 1 and 2; on the 5th June, 1928, for No. 3; and on the 12th June, 1928, for No. 4.

Forms of Tender obtainable from the above at a fee (which will not be returned) of 5s. for each schedule. 8477

Assistant Engineers (22) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. The foregoing officers are required to fill vacancies caused by the increase of the establishment of the Nigeria Public Works Department. Salary £480 a year for the first three years, then £510, rising by annual increments to £920. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 21½ years on the date of appointment, and should preferably have attained the age of 22½ and must not be over 35 years of age. Must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. Examination or have passed the Associateship in Civil Engineering of the City and Guilds Institute, or possess such other Degree or Diploma or Distinction in Engineering as may be considered satisfactory. Candidates whose qualifying Diplomas have been obtained without a College course should have had three years' practical experience of Civil Engineering under a qualified civil engineer. It is preferred that all candidates should have had two years' practical experience on good engineering work, subsequent to taking their degree or completing their articles, but under certain conditions this may be waived in the case of candidates in possession of an Engineering Degree.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/254. 8397

Assistant Engineers (4) REQUIRED by the GOVERNMENT of the GOLD COAST for a tour of 12 to 18 months' service, with possible extension. Salary £480 a year for three years, then £510, rising to £920 a year by annual increments. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 35, must be corporate members of the Institution of Civil Engineers or hold an Engineering Degree or Diploma recognised as granting exemption from Sections A and B of the A.M.I.C.E. examinations. Must be capable of taking complete charge of construction of buildings, bridges and roads, and have a thorough knowledge of surveying, quantities and measuring up of work.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/628. 8444

Wanted, Engineering DRAUGHTSMEN, used to neat, small and accurate work, and with good practical training. Experience with fully toleranced drawings an advantage. Salary £125, rising in £7 10s. annual increments to £150 plus Civil Service bonus, making salary at present cost-of-living figures £200 to £232. Appointment will not exceed 3 years' period in first instance, but is terminable by 1 month's notice either side. Preference given to ex-Service men.

Applications, with testimonials, and stating experience, should be addressed to SUPERINTENDENT, R.N. Torpedo Factory, Greenock. 8456

The Engineer

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PUBLIC NOTICES

Assistant Engineer Required by the GOVERNMENT of TRINIDAD for the PUBLIC WORKS DEPARTMENT, for three years' service, with possible extension. Salary, £400, rising to £450 a year by annual increments of £25. Free passages. Candidates, 25 to 30 years of age, preferably unmarried, must be Corporate Members of the Institution of Civil Engineers or hold an Engineering Degree or Diploma recognised as granting exemption from Sections A and B of the A.M.I.C.E. Examination. Must have had at least five years' practical experience on the Construction of Public Works and possess a good knowledge, both theoretical and practical, of Waterworks Construction.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/620. 8474

Assistant Engineers Required by the GOVERNMENT of NIGERIA for Railway Construction for a tour of 12 to 18 months' service, with possible extension. Salary, £480 a year for the first three years, then rising by annual increments to £920 a year. Free passages and quarters. When permanent quarters are not available, a commuted bush and travelling allowance of £9 a month is payable whilst engaged in the Colony upon construction work. Camp equipment provided. Outfit allowance of £60 on first appointment. Liberal leave on full salary. Candidates, aged 25 to 40, must be fully qualified Civil Engineers, who have had practical experience on Railway Construction.—Apply at once by letter, stating age and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/555. 8473

Research Department, WOOLWICH.
DIRECTORATE OF METALLURGICAL RESEARCH.
REQUIRED, JUNIOR ASSISTANT (Male).

Candidates must have a Degree in Metallurgy, with some research and practical experience, preferably in the Heat Treatment and Mechanical Testing of Steel.

Preference given to ex-Service men suitably qualified. Salary £160 per annum plus bonus. (Present emoluments £246 2s. per annum.) Annual leave 24 days.

Applications to be made by letter, accompanied by copies of not more than three testimonials and reference to any published work, to the CHIEF SUPERINTENDENT, Research Department, Woolwich, S.E. 18, from whom conditions of employment may be obtained. 8468

PUBLIC NOTICES

Administrative County of LONDON.
ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

The London County Council invites APPLICATIONS for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advanced study or research in applied science and technology, and will be tenable in the Dominions, the United States or other foreign countries.

Candidates must be British subjects and at least twenty-one years of age.

Further particulars and application forms (T.2.a./300) may be obtained from the Education Officer (T.2.a.), The County Hall, S.E. 1 (stamped addressed envelope necessary), to whom the form must be returned by 18th June, 1928.

MONTAGU H. COX,
8245 Clerk of the London County Council.

HALIFAX.

County Borough of Halifax.

The Corporation are prepared to receive TENDERS for the SUPPLY and ERECTION of a WATER FILTRATION PLANT.

Particulars, conditions and form of Tender may be obtained from E. P. Brook, Waterworks Engineer, on and after Monday, the 7th of May, 1928, on payment of the sum of One Guinea, which will be refunded on receipt of a bona fide Tender.

Tenders, sealed and endorsed "Tender for Mechanical Filters, Halifax Water Supply," to be delivered to my office not later than Twelve Noon on Thursday, the 31st of May, 1928.

The Corporation do not bind themselves to accept the lowest or any Tender.

PERCY SAUNDERS,
Town Clerk.

Town Hall, Halifax,
1st May, 1928. 8409

Hartlepool Port and Harbour COMMISSION.

ENGINEER, SECRETARY and HARBOUR MASTER (One Post) REQUIRED IMMEDIATELY. Salary £400-£500 per annum, according to experience. Candidates, under 35 years of age, who must be Associate Members of the Inst. C.E., must have had at least 5 years' practical experience of Dock and Harbour Works.

Applications, enclosing statement of qualifications, age, war service, &c., and copies of three recent testimonials, must be received before May 21st. —

J. D. HOWKINS, Secretary.
Hartlepool Port and Harbour Commission.
30,[Town Wall, Hartlepool. 8392

PUBLIC NOTICES

HIGHWAY AND RAILWAY BRIDGE ACROSS LILLEBELT.

Danish State Railways.
COPENHAGEN, DENMARK.

TENDERS are hereby INVITED for the CONSTRUCTION of a HIGHWAY and RAILWAY BRIDGE across Lillebelt, in accordance with conditions, &c., open to public inspection at "Tegnestuen for Lillebaeltsbroen" (the construction office of the Lillebelt Bridge), No. 40, Solvgade, Copenhagen, K., as well as at the Danish Legations in Berlin, Brussels, London, Oslo, Paris, Prague, Stockholm, and Washington.

The total length of the bridge is about 1175 m. and the weight of the steel superstructure will be about 15,000 tons.

The conditions and drawings (with Danish and English text) may be borrowed, against a deposit of Danish Kroner 500, by addressing the "Overingeniorens Kontor." The deposit will only be refunded when Tenders are submitted in due time and the borrowed objects have been returned not later than 14 days after expiration of the time limit fixed for submission of bids.

Tenders, marked "Tilbud paa Lillebaeltsbroen," may be submitted until the 1st of October, 1928, at Fourteen o'clock at "Overingeniorens Kontor," No. 40, Solvgade, Copenhagen, K.

Copenhagen in May, 1928.

THE CHIEF OF THE DEPARTMENT OF WAY AND WORKS.
8434

Liverpool Corporation Water- WORKS.
VYRNWY SUPPLY.
NEW FILTER BEDS, OSWESTRY.

The Water Committee of the Liverpool Corporation invite TENDERS for the CONSTRUCTION of FOUR FILTER BEDS at Oswestry in the County of Salop.

Plans may be inspected and copies of the specification and forms of Tender obtained at the Water Engineer's Office, 55, Dale-street, Liverpool, upon payment of the sum of Five Guineas, which amount will be returned upon receipt of a bona fide Tender.

Tenders to be received not later than Twelve o'clock Noon on Monday, the 21st May, 1928.

The Water Committee do not bind themselves to accept the lowest or any other Tender.

WALTER MOON,
Town Clerk.

Municipal Buildings, Liverpool,
May, 1928. 8418

Tenders are Invited by the Ministry of Public Works of The Egyptian Government for the CONSTRUCTION of (a) TWO DIPPER DREDGERS, each capable of an output of spoil in free-getting material of 80 metres cubic per hour measured in the solid; and (b) TWO SUCTION PUMP DREDGERS, each capable of an output of spoil in free-getting material of 200 metres cubic per hour measured in the solid; including RE-ERECTION in the Sudan and for the DELIVERY thereof in working order safely afloat on the River Nile.

Builders may Tender either for the two dipper dredgers or for the two suction pump dredgers, or for both groups.

Tenders will be received up to Noon on the 1st October, 1928. They must be submitted, in duplicate; one copy in Cairo to H.E. the Minister of Public Works, and the other in London to Messrs. Coode, Fitzmaurice, Wilson and Mitchell at the address given below.

The contract documents and the rules for, and full information as to, tendering may be inspected on and after June 1st, 1928, at any of the following places, namely :—

The Ministry of Public Works, Cairo.

The Offices of Messrs. Coode, Fitzmaurice, Wilson and Mitchell, Consulting Engineers to the Egyptian Government, 9, Victoria-street, Westminster, London, S.W. 1.

The Legations of the Egyptian Government at :
ENGLAND—Bute House, 75, South Audley-street, London.
GERMANY—Delbruckst 8, Grunewald, Berlin.
UNITED STATES OF AMERICA—1815 "Q"-street, N.W., Washington, D.C.
FRANCE—9, Rue la Perouse, Paris (XVIe).
BELGIUM—Rue de Turin, I., Bruxelles.
HOLLAND—Bute House, 75, South Audley-street, London.
ITALY—Palais Berlingieri, Rome.

Persons desiring to Tender may obtain copies of the contract documents between June 1st and July 1st, 1928, from either the SECRETARY-GENERAL, Ministry of Public Works, Cairo; or Messrs. COODE, FITZMAURICE, WILSON and MITCHELL, London, upon payment of Ten Egyptian Pounds.

Attention is drawn to Clauses 13 to 14 of the Instructions to Firms Tendering, and prospective tenderers are warned that their representative must have examined the re-erection site in the Sudan before July 15th at the latest, and that no Tender will be considered unless accompanied by evidence satisfactory to the Ministry of Public Works that this condition has been fulfilled. 8438

Engineering Supply Co. of AUSTRALIA, LTD.
E.S.C.A.
EDWARD-STREET, BRISBANE.

MR. LEE, Chief Engineer and Managing Director, will be in Great Britain this next three months.

PRINCIPALS desiring to get in touch with him, address H. D. LEE, 84, Fenchurch-street, E.C. 3. He is prepared to consider proposals for

MACHINERY, Supplies, Electrical Plant, &c., as suited for the STATE of QUEENSLAND. 8459

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SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a First-class DESIGNER, Competent to get out designs and estimates for Uniflow Engines and to carry the work through after the order is secured.
None but first-class men, who have had long experience in this line, need apply.
State age, give full details and experience and salary required, and when at liberty.
Address, 8332, The Engineer Office. 8332 A

WANTED, First-class MAN to Take Charge of Large View Room; high-class work; good Organiser absolutely essential.—Address, with full particulars of age, experience and salary required, 8432, The Engineer Office. 8432 A

ASSISTANT SURVEYOR, Who Must be First-class Draughtsman, WANTED IMMEDIATELY for Gold Mine on Gold Coast. Salary £540, 12 months' agreement, 1st class passages out and home; must pass drawing board test and medical examination.—Write, stating age, qualifications, and full details experience, to "G. K.," c.o. J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 8443 A

CHIEF TECHNICAL ASSISTANT REQUIRED by British firm of Engineers and Contractors in Egypt. Must have been educated at a Public School in England; should have had experience in Building Construction, including Steelwork and Reinforced Concrete. Knowledge of French and Italian desirable. Salary agreed upon will be increased when the successful applicant has acquired a working knowledge of Arabic.—Write in first instance, with full particulars and copies of testimonials and stating salary required, to "C.," Post Box 585, Cairo. P4508 A

ENERGETIC MAN REQUIRED, to Set Up and Supervise Light Machine Tools engaged on repetition work; knowledge of Modern Milling, Grinding and Inspection Methods essential. Progressive position to a man who knows his job.—Address, 8454, The Engineer Office. 8454 A

ENGINEER, with Technical Knowledge of the Design of Waste Heat Boilers.—Address, stating age, experience and salary required, 8445, The Engineer Office. 8445 A

ENGINEER'S STOREKEEPER WANTED for Sth. London who thoroughly understands parts and tools and is able to receive and dispatch goods. Ex-Naval man preferred.—Address, P4523, The Engineer Office. P4523 A

MECHANICAL ENGINEER of Good Education and shops experience WANTED by London Road Contracting Company to Supervise Operation and Repairs of all Plant. Salary £300 and fourpence mile using own car.—Address, 8469, The Engineer Office. 8469 A

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STEEL WORK ERECTION.—REQUIRED, Experienced SUPERVISING ENGINEER, to Set Out Jobs and Take Dimensions from Site. Accustomed to the control and distribution of men over a number of jobs, with good experience of work in London area.—Write in confidence, stating age, experience, and salary required, to Z.B. 686, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 8470 A

TECHNICAL ENGINEER REQUIRED as Assistant to General Manager; must have a knowledge of modern Machine Tools, energetic, with good commercial experience; good prospects for the right man.—Address, 8371, The Engineer Office. 8371 A

WANTED, CENTRIFUGAL and TURBINE PUMP DESIGNER and DRAUGHTSMAN, capable of producing efficient High and Low-lift Pumps at competitive prices with modern equipment. State experience and salary required.—Address, 8448, The Engineer Office. 8448 A

WANTED, DRAUGHTSMAN for Birmingham district, for Machinery Foundations and General Works Lay-out. Experience with Tube Mill Machinery preferred. State experience, age and salary required.—Address, 8436, The Engineer Office. 8436 A

WANTED, TWO or THREE Good DETAIL DRAUGHTSMEN, preferably accustomed to Machine Tool Work. State age, experience and salary required.—Address, 8441, The Engineer Office. 8441 A

A TEMPORARY SENIOR MECHANICAL DRAUGHTSMAN, with Shop training and good general experience. State age, qualifications and salary required.—Address, 8455, The Engineer Office. 8455 A

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JUNIOR DRAUGHTSMAN REQUIRED, with Constructional Engineering Experience of Drawing-out Workshop Details for Steel-framed Buildings.—Apply by letter to H. YOUNG and CO., Ltd., Thornycroft House, Smith-square, S.W. 1. 8447 A

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SITUATIONS WANTED

A.M.I. MECH. E. (30), 12 Years' General mechanical, electrical and transport erection and maintenance, managerial positions last 5 years, keen, energetic, DESIRES APPOINTMENT as ASSISTANT MANAGER or MECHANICAL ENGINEER.—Address, P4519, The Engineer Office. P4519 B

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For full particulars and advice, apply to:—8-11, TRAFFORD CHAMBERS, 58, SOUTH JOHN ST., LIVERPOOL. (Tel. Bank 1118). LONDON OFFICE:—65, CHANCERY LANE, W.C. 2. Ex.

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A Seven-Day Journal

The League of Nations and Wireless.

IN the autumn of 1925 a meeting of the Council of the League of Nations was held just in time to prevent a very serious dispute between Greece and Bulgaria. Ever since that time the League has been studying the problem of maintaining in times of emergency communication between Geneva and the countries represented on the League Council. It was recognised that failing some special means, independent of the general system of national communications, difficulties would be encountered in maintaining rapid and certain communication in times of general emergency, particularly just before and during the period of mobilisation. The League's Advisory and Technical Committee for Communications and Transit was instructed to study the technical difficulties of establishing a radio-telegraphic station for the League sufficiently powerful to enable it to communicate independently with the greatest possible number of member states. This committee has now submitted its report. It is, we gather, generally favourable to the establishment of such a station. Regarding the question of what use the station should be put to when it was not needed for emergency purposes, the Committee points out that the station could be employed to distribute by circular wireless telegrams, Press news, Government information and important League documents. In addition, it could handle the large amount of correspondence from and to Geneva now conducted by mail and telegraph. On the present basis, the traffic is estimated at 300,000 words a year, which would rise to at least 1,200,000 words when the circular wireless services were instituted. The cost of construction is estimated at £50,000 and the annual working expenses at £8000. The annual receipts during the first few years would be between £4000 and £6000. The political and practical aspects of the scheme are to be considered by the Council and the Assembly next September.

The Last of the Airship R 33.

WE learn that the airship R 33 is now being broken up. This vessel, a sister ship of the R 34, which made the double journey across the Atlantic in 1919, and which subsequently was damaged and broken up, was a copy of a captured German airship, the Z 33, brought down in this country in 1916. She was built at Howden by Armstrong, Whitworth and Co., Ltd., and with a gas capacity of 1,950,000 cubic feet, had a gross lift of 59 tons and a disposable lift of 30 tons. She was driven by five "Sunbeam" engines of 250 horse-power each and had a maximum speed of 62 miles an hour. Her normal crew numbered twenty-two. Although she took no conspicuous part in the war, and did not acquire fame, as did her sister ship, by crossing the Atlantic and returning, the R 33 rendered in the later years of her life great service in the cause of airship development. With her aid a lengthy series of full-scale experiments and measurements were made in actual flight, with the object of providing new and confirming existing data on the stressing of airships. The information so obtained was made use of in the design of the 5,000,000 cubic foot airships "R 100" and "R 101," now under construction in this country. In addition, the "R 33" was used to demonstrate the possibility of taking up aeroplanes—two Gloster "Grebes"—and launching them from the airship when in full flight. In April, 1925, she broke away in a gale from her mooring mast at Pulham, and with her nose badly damaged and with only a nucleus crew on board, drifted out across the North Sea. After a fight with the elements extending over thirty-six hours, she was brought safely back by the skill and courage of her crew and the senior officer on board at the time, Flight-Lieutenant R. S. Booth.

The Safety of Horizontal Milling Machines.

IN our issue of April 29th, 1927, we published in full the draft regulations which the Home Secretary intended to make under the Factory and Workshop Act, 1901, with the object of promoting the safe operation of horizontal milling machines. To those regulations various objections were raised. After discussion with the Engineering Employers' Federation and the railway companies, the Home Secretary has this week issued the regulations in an amended form. Comparison shows that the chief alteration relates to the regulation governing the design of the guard for the cutters. It is now required that "the cutter shall be fenced by a strong guard properly adjusted to the work," instead of being "covered by a strong and readily adjustable guard." The guard is either to be provided with adequate side flanges or to extend on each side of the cutter to the end of the arbor or to the arbor support or to a distance of not less than half the diameter of the cutter. Face milling cutters are exempted from those to which this type of guard is to be applied. Exemption from the use of a guard of any kind is granted in the case of a milling cutter used in a spindle over 2¼in. in diameter or on an arbor over 2in. in diameter at the place where the cutter is mounted. Neither is a guard insisted upon in the case of a horizontal milling machine employed for making tool jigs or gauges for use in the factory or for undertaking other accurate operations in which the position of the work relatively to the cutter during the cutting process is determined by the operator and is not merely governed by a previous setting up of the machine. The absence of a guard is also permitted in the case of internal milling, and milling other than face milling, automatic gear cutting, automatic hobbing, automatic profiling and thread milling. The new draft regulations may be taken objection to in writing up to May 29th.

Launch of a New Submarine.

H.M.S. "ODIN," which was launched at Chatham Dockyard on May 5th, represents a further development of the ocean-going type of submarine. This vessel is one of a batch of six boats ordered under the Navy Estimates for 1926-27. The others are being built by contract, three by Vickers-Armstrong and two by Beardmore. It is officially disclosed that they are considerably heavier than the "Oberon," the nameship of the "O" class, which went afloat in September, 1926, her displacement being 1345 tons, on the surface and 1805 tons when submerged. In the "Odin" the displacement has been increased to 1540 tons above, and 2020 tons below, water. No particulars of the machinery or armament of this boat are known as yet, but it may be pointed out that the "Oberon" herself has internal-combustion motors of 2700 B.H.P., which give her a maximum surface speed of 15 knots, and that she carries one 4in. gun, one smaller piece, and eight torpedo tubes. Moderate speed and powerful torpedo armament would thus appear to be the main characteristics of the "O" design. So far as the British Navy is concerned, the "Odin" is surpassed in size only by the "X. 1" and "K. 26" of 2525 tons and 2140 tons respectively. It remains to be seen whether the six boats of the "P" class, which were provided for in the 1927 Estimates, and are now under construction, will show a further advance in dimensions. The largest submarine launched up to the present is the American minelayer "V. 4," of 2890 tons, but a 3000-ton submersible cruiser for the French Navy is now on the stocks at Cherbourg. Japan has already built several boats of 1970 tons, and her latest vessels are believed to be even larger.

Electric Transmission Towers.

IN our issue of April 20th we mentioned that tests on one of the transmission towers to be used in connection with the Central Scotland Electricity Scheme were about to be made. These tests have now been completed and the work of erecting the towers is about to begin. Among the first towers to be put up in Scotland three will be in the Edinburgh area, where they will be erected in their permanent positions for the purpose of enabling Sir Reginald Blomfield to obtain an accurate impression of their appearance, and of aiding him in the task of advising as to the artistic treatment necessary to make them harmonise with their natural surroundings. The tower that has been tested is of galvanised steel, and in its untreated state it is not likely to be considered a decorative addition to the amenities of the Scottish countryside.

The South-East England Electricity Scheme.

SPECIFICATIONS for the main overhead transmission lines for the London and South-East England Electricity Scheme are about to be issued by the Central Electricity Board, and those for the transforming stations and switchgear will follow in due course. The project, which will involve an expenditure of £12,000,000, is designed to supply electricity for power and lighting to a population of 11,000,000 people, living in an area of 8828 square miles, with boundaries at Peterborough in the north, Aylesbury, Reading and Basingstoke in the west, Worthing, Brighton, Eastbourne, Hastings and Folkestone in the south, and Ipswich, Colchester, Southend and Ramsgate in the east. Five hundred and eleven miles of transmission lines will be employed as against 225 miles for the Central Scotland scheme. An indication of the magnitude of the contracts about to be placed can be gathered from the fact that in the latter case tenders accepted in February represented nearly £300,000. Lattice towers made of galvanised steel and conforming to the design settled in consultation with Sir Reginald Blomfield will carry the lines. The towers will be approximately 80ft. high and 16ft. square at the base, and will be spaced about 300 yards apart. It is expected that the next electricity scheme to be issued will relate to Lancashire and North Wales.

The New Nelson Liners.

ON Thursday of last week, May 3rd, there was launched from the East Yard of Harland and Wolff, Ltd., Belfast, the 14,450 gross ton motor passenger and cargo liner "Highland Monarch," which is the first of five similar vessels ordered for the service of H. and W. Nelson, Ltd., between Great Britain, Spain and Portugal and South America. The new liner has a length between perpendiculars of 520ft., with a breadth of 69ft. and a depth to the upper deck of 35ft. 9in. Her propelling machinery comprises two sets of eight-cylinder Harland-B. and W. double-acting four-cycle engines. Each engine will drive its own air injection compressors, and the main cylinders will be cooled by fresh water, while the pistons will be oil cooled. An exhaust gas boiler, which may also be separately oil fired, will be installed to work in conjunction with either one or both of the main engines. Electricity will be widely used throughout the ship, and the auxiliary generator equipment will include four 200-kW sets, driven by Harland-B. and W. trunk type engines. As five of the cargo holds and most of the 'tween deck spaces are to be insulated and arranged for the carriage of chilled meat, considerable refrigerating plant will be required. The main refrigerating machinery is of especial interest, as it will be, we believe, the first of its kind to be driven by horizontal oil engines. There will be two duplex double-acting anhydrous ammonia compressors, with a bore of 11½in. and a stroke of 15in., each connected to a four-cylinder *vis-à-vis* Premier oil engine. The designed output of the engine is 240 B.H.P., and the normal working speed will be about 90 r.p.m., but speeds up to 180 r.p.m. may be used if desired. The appearance of the new Nelson liners will resemble that of other new large motor liners with their two low funnels and a cruiser stern. Accommodation will be arranged for 135 first-class and 66 intermediate-class passengers, as well as for a number of emigrants.

The Thames Bridge Schemes.

THE report of the committee of engineers appointed by the Minister of Transport to consider the scheme for a double-deck rail and road bridge at Charing Cross, as recommended by Lord Lee's Commission on Cross-River Traffic, was published on Wednesday, May 9th. The report is accompanied by full particulars of the alternative scheme which the committee favours, namely, the removal of Charing Cross Station to the south side of the Thames, and the construction of a new high-level road bridge across the Thames in place of the existing Charing Cross railway bridge and the footwalk known as Hungerford Bridge attached to its down-stream side. This scheme also contemplates the widening of the existing Waterloo Bridge, and, altogether, its cost is estimated at £10,770,000, as compared with £11,720,000, the committee's estimate for the Lee Commission's double-deck bridge. It is reported that the Committee's alternative scheme is regarded with favour in Government circles, and that the Government would be prepared to contribute from the Road Fund a substantial portion of the 11 million or so required to carry it out. The attitude of the Southern Railway towards the scheme has yet to be disclosed. It may be recalled in this connection that the company's chairman at a shareholders' meeting a year or so ago said that to consent to the transference of Charing Cross Station to the south side of the river would be suicidal on the part of the company. The suggestion of the transference of the Southern Railway's west-end terminus to a site adjoining its Waterloo Station has already prompted the outlining of schemes for developing the tube railways serving the Waterloo area. One such scheme is said to contemplate the construction of a new tube between Waterloo and Victoria.

Some Recent Clyde Launches.

UP to the present the amount of tonnage launched on the Clyde this year compares well with the average for the corresponding period in recent years. At the end of last week William Denny and Brothers, Ltd., launched at Dumbarton the 1800-ton turbine steamer for the Newhaven–Dieppe service of the Southern Railway Company. The third turbine steamer for the new Belfast service of the L.M. and S. Railway Company is approaching completion. Messrs. Brown have received an order for the L.N.E. Railway Company for a new steamer for its Hook of Holland service. At the launch of the oil tanker, the "Pass of Ballater," from the Blythwood Shipbuilding Company's yard at Scotstoun, last week, it was announced that the owners of the vessel had ordered a further sister ship, making the third of that particular type. The Blythswood Shipbuilding Company, Ltd., is also to build a 300ft. oil tanker of 3200 tons capacity, to the order of the Iranian Tanker Company, Ltd., which will be propelled by the first Richardsons-Westgarth double-acting two-stroke airless injection engine. The new motor will be a three-cylinder unit, with a bore of 21½in. and a stroke of 38in., and will be designed for an output of 1250 B.H.P. at 90 r.p.m., and a mean indicated pressure of about 78 lb. per square inch. Electrically operated auxiliary machinery will be employed. Details of the engine design may be found in an article published in THE ENGINEER of April 30th, 1926, in which the experimental unit was described and illustrated. At the Fairfield yard, Govan, there was launched on Tuesday last, May 8th, the refrigerated cargo motor vessel "Karamea," the second ship to be built for the New Zealand service of the Shaw, Savill and Albion Company, Ltd. The first vessel, the "Taranaki," was handed over last week. The main propelling machinery comprises twin-screw Fairfield-Sulzer motors, and there are four Allen generator sets of the firm's latest design.

20,000 kW Brown-Boveri Turbo-Generator at Rotterdam.

No. I.

IT is not too much to say that the high reputation of the reaction steam turbine on the Continent, both as regards efficiency and reliability, is due almost exclusively to the work of Messrs. Brown, Boveri and Co., of Baden. The theoretical advantages of the reaction principle were recognised by the firm from the earliest days, and they devoted themselves to its development with a scientific insight and an engineering skill which have enabled them to undertake with confidence the manufacture of the immense unit of 160,000 kW capacity, now being built at Baden for the Hell Gate Station at New York. Machines of such a magnitude are, however, likely to be exceptional for many years to come. They strike the imagination because of their size, and they serve to prove, in the most effective manner possible, the ability and courage of their makers; yet the latter, we think, would be the first to admit that they present no more difficult problems of design than those which have to be solved in the case of machines of less spectacular dimensions. These latter machines will always be the more numerous, and, for that reason, the details of their construction and performance will always have the greater practical interest for engineers. They are built, moreover, under more competitive conditions, so that the merits of their design are tried as severely by the commercial as by the technical test. What form that design will take must always be largely governed by questions of size and of duty required. The nature of the load, the price of fuel and many other factors will determine the final choice. Experience, moreover, will justify the decision or otherwise. No one type of machine can be best for all conditions, but for the requirements of the average modern power station one can fairly say that one of the most successful types of turbine has been the three-cylinder tandem machine which represents Messrs. Brown Boveri's standard practice for units of more than about 10,000-kW capacity. The design permits of short casings and therefore obviates distortion troubles; the greater rigidity of the short rotors enables clearances to be kept to a minimum, and the fullest advantage of the reaction principle to be obtained; while the employment of three cylinders allows the steam flow to be so arranged that end thrust is automatically balanced without the use of dummy pistons. In spite, moreover, of the use of an extra cylinder, the machine is very little longer than a two-cylinder machine of equal output.

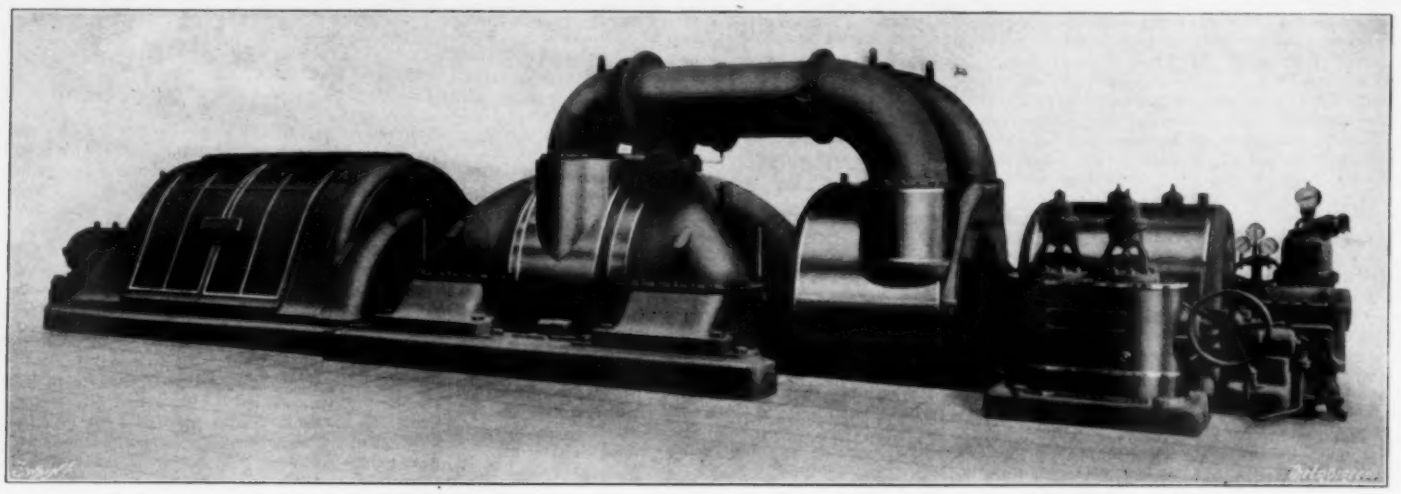


FIG. 1—20,000 kW THREE-CYLINDER BROWN, BOVERI TURBINE

The appearance of a typical Brown-Boveri three-cylinder turbo-generator is well shown by the photograph reproduced in Fig. 1 herewith. Such a machine has been installed in the Schiehaven power station at Rotterdam, and this set, by the courtesy of its makers and of Dr. J. J. Smits, the director of the station, we are able to describe in considerable detail. The Schiehaven unit has a maximum continuous rating of 20,000 kilowatts, and a speed of 3000 revolutions per minute. We will first consider the turbine alone, leaving its arrangement in the station with respect to its auxiliaries until we take up the description of the condensing plant. The turbine, like the other machines in the same power station, was designed for steam at a pressure of 12 kilos. per square centimetre (170 lb. per square inch) at the stop valve, superheated to 350 deg. Cent. With circulating water at 15·0 deg. Cent., the absolute condenser pressure is 1·2in. of mercury, when the machine is carrying its normal or most economical load of 16,000 kW.

A section through the turbine is reproduced in our Supplement. As will be seen from the drawing, the high-pressure cylinder and the intermediate-pressure cylinder are both of the single-flow type, while the double-flow arrangement is employed for the low-pressure cylinder. The reaction principle is used throughout, except that two impulse wheels, each with a single row of blades, are provided in front of the reaction blading of the high-pressure cylinder. For all loads up to 16,000 kilowatts the steam passes through these wheels before passing through the reaction stages, but above that load steam is admitted directly to the first reaction stage. The number of reaction stages in use is thus constant at all loads. It will be noticed also that the steam flow through the high-pressure and intermediate-pressure cylinders is in opposite directions. This arrangement results in a practical balance of end thrust, so far as these two cylinders are concerned.

After leaving the intermediate cylinder, the steam passes to the low-pressure horizontal length. The steam enters at the centre of the cylinder by means of the two overhead pipes which form so characteristic a feature of the machine. Each pipe is provided with an expansion joint in the the low-pressure cylinder, and flows in both directions to the condensers. There is thus no end thrust on this rotor, either. Hence the whole turbine is balanced axially without the employment of any dummy pistons; the leakage due to the latter is eliminated and the space which they would have occupied is saved. Any residual end thrust which may exist is taken care of by a segmental thrust block of the Brown-Boveri type, the design of which will be illustrated later. The double-flow arrangement of the low-pressure cylinder, besides eliminating end thrust, has the further practical advantage of halving the volume of the steam which otherwise would have to pass through the final rows of blading. The latter may

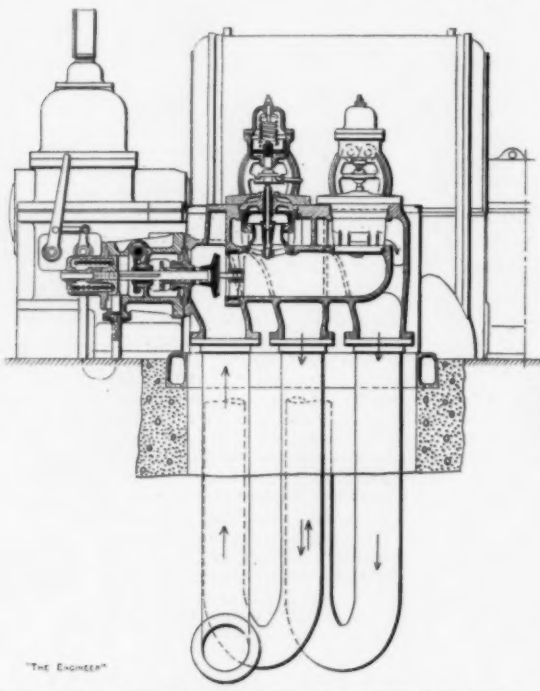


FIG. 2—STOP VALVE, THROTTLE, AND OVERLOAD VALVE

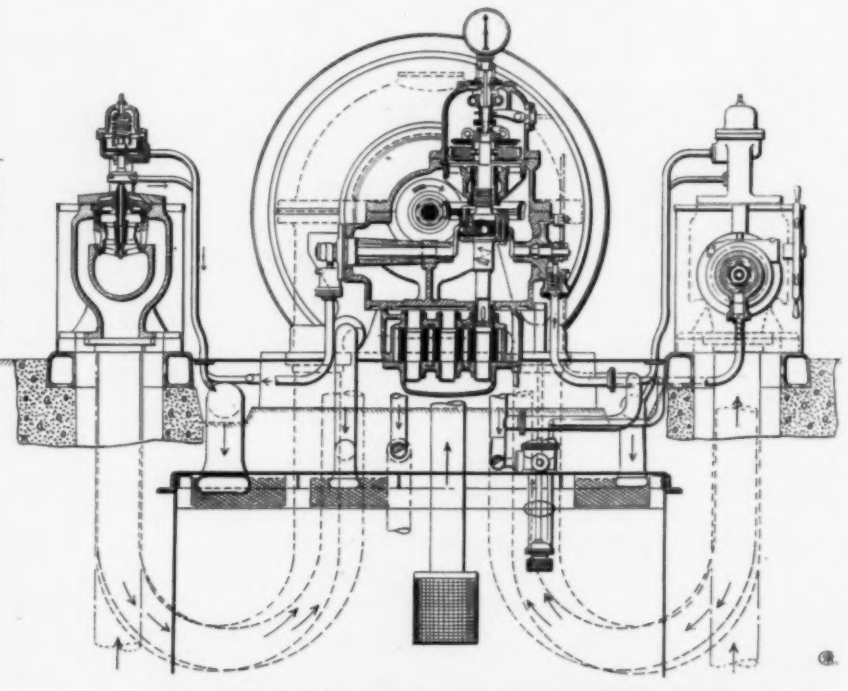


FIG. 3—CROSS SECTION THROUGH GOVERNOR CASING

therefore be kept to a reasonable length, while at the same time the velocity of the steam is kept low. The reduced velocity of the steam on its final exit from the blading naturally brings about a reduction of the "leaving losses," and thus conduces to the greater efficiency of the double-flow type of cylinder. Furthermore, the duplication of the exhaust branches facilitates the duplication of the condenser, which is a convenience in many ways, and particularly as regards opportunity for cleaning and repair.

The high-pressure cylinder casing is made of cast steel. The inlet steam belts in the upper and lower halves are quite separate, so that there is no high-pressure joint on the centre line of the machine. The intermediate and low-pressure cylinders are of cast iron. The turbine is anchored to its foundations at two points, namely, at the bearing between the high

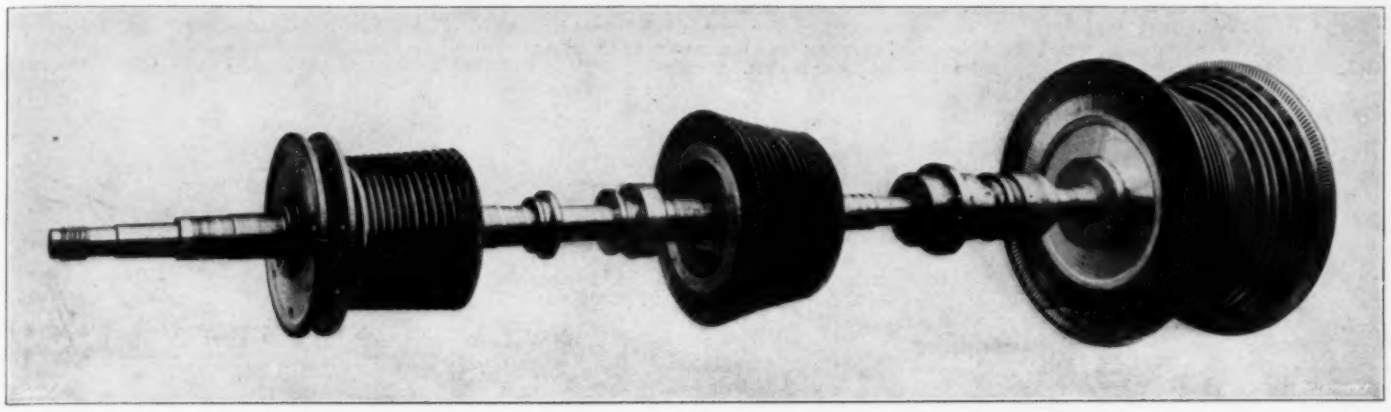
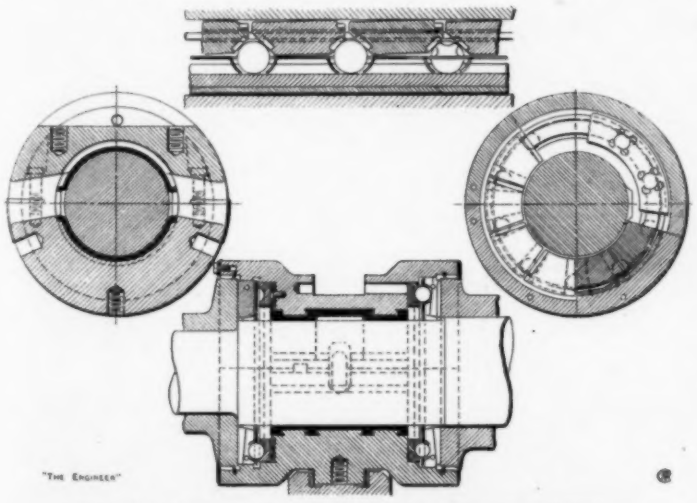


FIG. 4—ROTOR OF THREE-CYLINDER TURBINE

and intermediate-pressure cylinders and at the centre of the low-pressure casing. At all other points of support it is free to move longitudinally under the influence of changes of temperature. So far as general design is concerned, the care taken to give a good lead to the steam from the last row of blades to the condensers should be noticed. There are no projecting corners to create eddies, and the curved ribs, traversing the lower halves of the exhaust ends, are also formed to guide the steam flow. It is the attention to points like these which makes so much of the difference between good and mediocre design.

A cross-section of the turbine through the governor casing is shown in Fig. 3. On each side of the machine there is a hand-operated stop valve, a throttle valve and an overload valve. Each of these sets of valves is independent of the other and of the turbine, being



FIGS. 5 TO 8—DETAILS OF SEGMENTAL THRUST BEARING

connected to the latter by a pair of U-shaped pipes of sufficient flexibility to prevent any strain on the turbine casing. The duplication of the valves is for the purpose of facilitating the passage of the large quantity of steam without the use of valves and pipes of unduly large dimensions. All valves are operated by the same oil pressure, but the springs which tend to hold them closed are so adjusted that the two throttle valves open first one after the other, and then the two overload valves one after the other. The steam from each side of the turbine flows to its own nozzle group, the nozzles being divided into left-hand and right-hand groups down the centre line of the turbine. In starting the turbine, it is usual to open first one of the hand-controlled stop valves a little way and then the other, so that the machine may be uniformly warmed. The arrangement of one of the valve groups is illustrated in Fig. 2. The stop valve is horizontal and is opened by a hand wheel and worm gear. The nut into which the spindle is screwed by the rotation of the worm wheel is held in place by a catch against the action of a strong spring. When the catch is released, either by the action of the run-away governor or the emergency hand-trip lever, the spring instantly closes the valve, the spindle sliding through the worm wheel on a feather without regard to the position of the hand wheel or the worm gear. A reference to Fig. 2 will make the mechanism clear.

The Brown-Boveri method of governing turbines directly by means of oil pressure without the use of rods, joints or levers of any kind, is so well known that it is sufficient, now, merely to mention the principle. The steam throttle valves and overload valves are opened and held open by oil pressure acting under pistons on their spindles against the action of strong springs. The oil-pressure pipe leading from the pump is divided into two circuits through which the oil returns. In one circuit there is merely a fixed throttling device, while in the other is a variable throttling device actuated directly by the governor. The oil in this latter circuit acts underneath the valve pistons before being throttled. Should the speed of the turbine fall, the governor closes the variable oil throttle valve, thus restricting the return of the oil to the pump and increasing the pressure tending to open the steam valves. When the latter are opened to their full extent, should the turbine speed still be lower than normal, the oil pressure continues to increase and the overload valves come into action. Since the steam valves can only be opened by oil pressure, it is evident that provision must be made for obtaining this pressure before the turbine starts. The bearings must, of course, also be lubricated before starting. Oil pressure for these purposes is obtained from a small auxiliary oil pump, of the centrifugal type, driven directly by a small steam turbine wheel on the pump spindle. This pump is also used if, for any cause, the delivery pressure of the main pump falls below its predetermined value, as, for instance, when the turbine is being shut down.

In Fig. 3 the main oil pump, of the gear type, can be seen driven directly by the lower end of the governor spindle. At the upper end of the governor, attached to the sliding sleeve, is the oil throttle valve, which controls the pressure under the steam valve pistons. The emergency, or run-away governor, is situated immediately below the worm wheel on the governor spindle. It consists of an excentric ring, held centrally at normal speeds by a spring. Should the turbine speed exceed a predetermined value, generally 10 per cent. above the normal, the ring flies out under the action of centrifugal force and strikes the arms at each side, and causes the instant closing of the two stop valves. The mechanism by which this is brought about is as follows:—The catch which holds the stop valve open is supported by a number of balls filling a curved tube, as shown in Figs. 2 and 3. The contact surfaces between the catch and the piston on the valve spindle are bevelled at an angle of 45 deg. so that nothing but the reaction of the balls prevents the catch being driven down by the spring. At the other end of the tube, pressure is maintained on the balls by a cam. This cam is turned when the emergency governor strikes the arm or when the emergency trip lever is operated by hand. The movement of the cam allows the balls to move in the tube, and thus the main stop valve to be shut by its spring. When the turbine has tripped out, it is restarted by turning the stop valve hand wheel to the closed position. This restores the piston on its spindle to its normal place, and the catch can be reset by a movement of the hand lever. The stop valve can then be reopened by hand.

In the sectional drawing it will be seen that the high-pressure and intermediate-pressure rotors of the turbine are rigidly coupled together, while a flexible coupling of the double claw and sleeve type connects these rotors to that of the low-pressure cylinder. The low-pressure rotor is connected to the rotor of the alternator by a flexible coupling of the same type. The appearance of the three turbine rotors when coupled together is shown in the engraving, Fig. 4. It may be noticed that the rotors shown in the illustration are not actually those from the Schiehaven machine, the number of blade rows being a little different, but the general design is the same. The glands, which serve to prevent leakage where the shafts leave the cylinders are all of the labyrinth type, which Messrs. Brown, Boveri have found to give the most satisfactory results.

The steam which has served its purpose in sealing the high-pressure glands, is led to the intermediate-pressure glands and thence to the low-pressure glands, performing the same duty for these in turn. By this device gland losses, which add an appreciable item to the steam consumption of some makes of turbine, are reduced to a very small value. The high and intermediate-pressure rotors, which form, mechanically, a single piece, are located longitudinally by a double thrust bearing housed in the pedestal between these rotors. A similar thrust bearing in the front pedestal of the low-pressure rotor serves to locate the latter. The design of these bearings will be understood from the drawings, Figs. 5 to 8. The principle is that of the

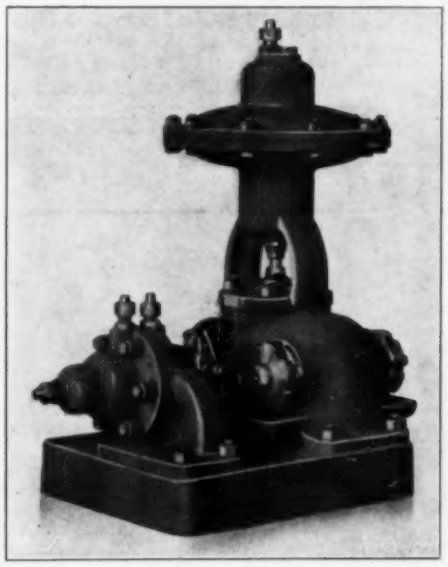


FIG. 9—AXIAL THRUST CONTROLLING DEVICE

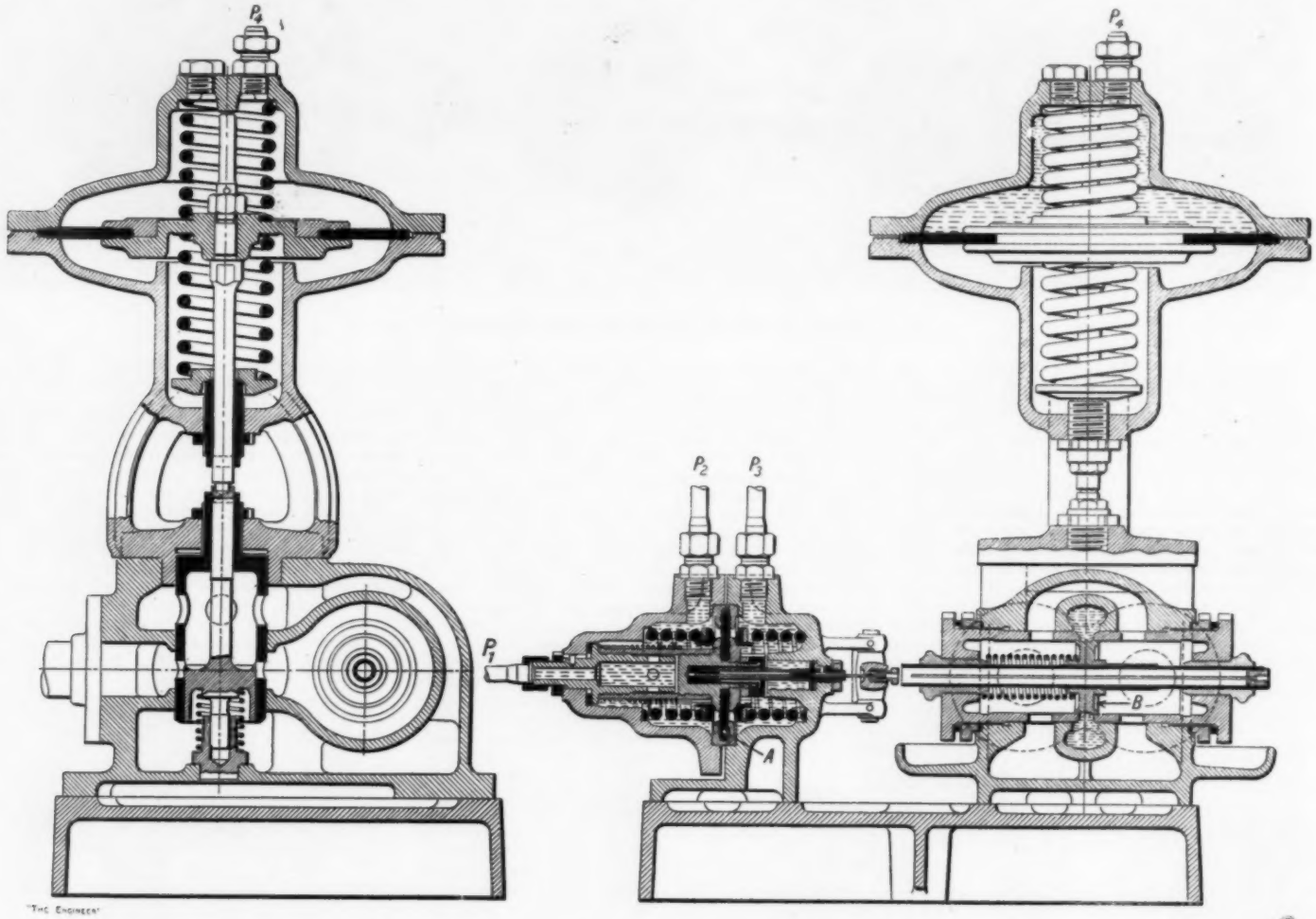
pivoted block bearing which, by its self-lubricating properties, is able to carry axial thrusts immensely greater than any form of plain collar bearing. Messrs. Brown, Boveri and Co., however, do not actually pivot the segmental blocks, but arrive at an equivalent result in a highly ingenious manner. The essential element of the Brown-Boveri thrust bearing is a ring of segment-shaped bronze blocks held loosely together by a wire threaded through them near their outer periphery. In the bearing shown in Figs. 5 to 8 there are ten such blocks. One face of each block is scraped and forms one of the rubbing elements. These faces, when the bearing is assembled, bear against a steel collar on the turbine shaft. The radial edges of the other side of the blocks are bevelled off and in each is inserted a hardened steel disc. These discs form point-contact seatings for a number of hard steel balls held

loosely in holes punched in a simple form of brass cage. Behind the row of balls is a steel ring, provided with a circular groove which locates the balls radially. This ring is fast in the bearing proper. It will be obvious that when axial pressure comes on such an arrangement it is transmitted by each ball to the adjacent pair of segments by means of the steel discs already mentioned, so that the pressure from any neighbouring pair of balls can be resolved into a single resultant force normal to the segment between those balls. As the steel discs are not inclined at equal angles to the segment faces this resultant does not pass through the centre of each segment, so that to balance it the working pressure on the segment is less along one side than along the other. Hence the segments will tend to adjust themselves as shown in Fig. 7, giving an easy lead for the oil to each. The ring of segments is prevented from rotating bodily by small dowel pins. It should be noticed that, in addition to the pivoting action of the segments, a further advantage is gained by the design, namely, the automatic equalisation of pressure on all the segments. None can be more heavily loaded than the others, for any excess of load would cause it to be pushed back, forcing its neighbours more forward at the same time by the action of the balls behind them. The main bearing is lubricated at both sides on the horizontal diameter, as shown in Fig. 8, the oil passing along grooves in the steps and lubricating the thrust blocks before finally escaping.

Following the description of the thrust bearing, it is convenient to refer to the ingenious safety device adopted by Messrs. Brown, Boveri and Co. to protect the machine against excessive end thrust, should any untoward event upset the normal steam balance of the rotors. The apparatus, which is illustrated in Figs. 9 to 11, acts on the principle of automatically reducing the load on the turbine when excessive end thrust occurs, until the end thrust is restored to a safe value. Referring to Fig. 11, it will be seen that the essential part of the device is a spindle which is free to move longitudinally within certain limits. This spindle is attached to a diaphragm which is acted on by the steam pressures at various parts of the turbine. As all the areas of the diaphragm so acted upon bear the same proportion to each other as that existing between the corresponding area of the turbine cylinders, the axial thrust on the spindle will be proportioned to the axial thrust on the turbine shaft, and will be balanced when the thrust on the turbine shaft is balanced. This agreement holds for all loads, for, as is well known, the pressure at any point of a turbine varies proportionally to the volume of steam passing, so that the ratios of the pressures at various points of the turbine remain constant, even though the load varies. If, for any cause whatever, the distribution of the pressure on the turbine changes, the equilibrium of the spindle of the safety device is disturbed. The spindle then moves and a piston which it carries uncovers a port, allowing oil to flow away from the turbine governing system, and so reducing the load on the machine. Should the correct steam conditions be restored in the turbine, the spindle again covers the port, the oil pressure on the system is restored, the steam inlet valve is reopened, and the turbine again picks up its load automatically and continues to run normally.

Referring to Fig. 11, the diaphragm A is acted on by three different steam pressures p_1, p_2 and p_3. The pressure p_1 is that existing at the high-pressure end of the steam turbine; p_2 is the pressure between the high-pressure and intermediate-pressure turbine cylinders; while p_3 is that existing at the low-pressure end of the intermediate-pressure turbine cylinder. The pressures p_1 and p_3 both tend to push the spindle to the right, and their sum is balanced by the pressure p_2 acting on a larger area and tending to move the spindle to the left. Should the spindle move, owing to any unbalancing of the pressures, the piston B uncovers the port shown, and the escape of oil lowers the pressure in the governing system, and so reduces the load on the machine. Fig. 10 illustrates a further safety provision, which reduces the load if the vacuum fails. The pressure p_4, acting on the upper side of the diaphragm, is that at the exhaust end of the low-pressure cylinder. The diaphragm is held in balance against this pressure by means of the springs shown above and beneath it. Should the condenser pressure become too high, the diaphragm sinks and the piston attached to the lower part of its spindle lets the oil pressure escape by uncovering the ports shown. The load on the turbine is thus reduced, and maintained at a safe value, until correct condensing conditions are again restored.

(To be continued.)



FIGS. 10 AND 11—DETAILS OF AXIAL THRUST CONTROLLING DEVICE

IN a note in the *Ironmonger* "Vulcan" records that there is a tin-plate works about half a mile from the ancient city of Caerleon, surrounded by green meadows, historic farmsteads, wooded uplands, quiet, shady lanes and orchards. One of the farmhouses is so close to the works that only a low wall separates the mill from the farm. The entrance to the mill is almost concealed in summer by an ancient and very beautiful pink hawthorn tree, which, when fully in bloom, mingles its fragrance with other odours associated with tin-plates. In keeping with the old-world character, the motive power of the mill is a breast-feed water wheel. Yet this mill is able successfully to maintain competition with others of more modern equipment.

General Development of the Locomotive.

(By a Continental Engineer).

No. V.*

BRITISH LOCOMOTIVES *(continued)*.

To obtain sufficiently long connecting-rods the distance between the driving axle and the centre of the bogie cannot be less, with powerful engines, than 11ft. to 12ft. in round numbers. This is an average figure for 4–4–0 engines, but when we come to the "Atlantic" or to the 4–6–0 type, it corresponds to a rather long engine. Good and fine engines of this class have been designed with inside cylinders—L. and Y., Caledonian, L. and N.W., Great Western, &c.—but it is not less a fact that the introduction of the above-named types has developed the use of outside cylinder—the second coupled axle being then the driving—or of three and four cylinders, mostly at first with inside, and later with outside valve gears. With three or four cylinders, one or two of them can be placed inside without drawback, by reason of the smaller diameter and stroke of the pistons—if not compound or, if so, with the low-pressure cylinders outside. Though more powerful, the engines so designed present often a smaller wheel base than similar engines having inside cylinders driving the first coupled axle.

But the large ten-wheel type fitted with outside cylinders has proved to be not quite as steady as the preceding inside cylinder engines unless reciprocating counterweights be very heavy, with the resulting effect of hammer blow. The three or four cylinders arrangement is the best remedy. Large engines having outside cylinders of great volume, notwithstanding the leading bogie or Bissel truck, are rather rough riding and have a marked side motion, even when running at moderate speeds. That does not cause great inconvenience with a strong permanent way, but in all cases well-balanced engines do not strain the track.

The condition of the permanent way has an important bearing on the devices adopted for the spring gear of engines. As the road beds are well laid and carefully maintained in Great Britain, these gears are, on most engines of that country, of the plainest description and without the refinements found elsewhere. On a good many engines the springs are so arranged as to have the hangers in compression in underhung springs, instead of in tension which gives more freedom to the spring and allows the axle-boxes to move more easily in their guides. Sometimes there are no means of adjustment, the hangers having

* No. IV. appeared May 4th.

no nuts and being simply articulated on eyes formed at each end of the uppermost plate. Equalising levers or compensating gears between two sets of coupled wheels are far from being general, and in engines such as "Atlantics" or "Pacifics" the springs of the driving wheels are not connected by such gears with the trailing axle.

An equalising lever between two sets of coupled wheels, at least, is useful whatever be the excellence of the road, as it prevents overweight falling on one of the axles after some mileage has been run. With equalising beams the axle load limit may be higher, as the allocation of the weights cannot be altered, and there is no need to provide against occasional additional load on one of the coupled axles. The same may be said of well-balanced four-cylinder locomotives having scarcely any reciprocating counterweights, for there is then, even when the engine runs at a great speed, no overload or hammer blow effect on the rail; in one word, the static and dynamic reactions on the permanent way are not very different.

This British practice is exactly the reverse of the American, the locomotives built in the United States having all their springs on the same side connected by articulated equalising beams. The bogie and bissel trucks being loaded in their centres, the engines are thus supported on three points and the distribution of weight on any axle cannot be altered. This disposition was useful in the beginning by reason of the uneven road beds, but American designers have maintained it on recent engines, called to run on much better tracks, notably in the eastern districts. British engineers do not appear to care for such equalising, holding that it has a marked tendency to make the engines roll and pitch at high speed. Perhaps, in this particular case, they rely on a rather exceptional confidence in the strength and elasticity of the permanent way of their country. This pitching and rolling gives rise only to easy and smooth reactions. It does not strain the permanent way and never causes rough riding.

The American equalising practice has spread on the Continent and most of the recent French engines are designed on that principle.

Whilst on this subject we must mention the use of coiled springs placed under the axle-boxes and used in compression. They are only employed for one driving axle. The arrangement is essentially British and is never found on foreign engines. It has some advantages, especially as being convenient in the limited space under the engine. Coiled springs have less inertia than laminated springs and are more quickly sensible to any variation in the load; their use under several pairs of wheels would make the engine too "lively."

It is noteworthy that good tracks and good coal make things easier, but it must be acknowledged that, generally speaking, British locomotive engineers have made the best of their advantages. Their engines are generously built and they have never encouraged lightness in parts considered, often wrongfully, as not vital. Extreme lightness may appear at first sight to be the proper result of researches and refinement, but it is a source of frequent repairs. A good example is to be found in the strong and well-stayed frames and buffer beams, in substantial wheels, and connecting or coupling rods, especially designed for easy and cheap manufacture.

Before the use of cast steel wheel centres became general, British locomotive engineers kept to wrought iron wheels constructed out of a number of independent spokes welded together, which necessitated expensive machining, but which, despite the risks of flaws, were stronger and more reliable than the hot stamped or pressed iron wheel centres used on the Continent, the metal of which, not being forged, was often crystallised and had a low tensile strength. With such wheels having thin rims the steel tires played, happily, the part of real hoops. But all that is now a thing of the past, the general use of cast steel centres having suppressed differences in this respect, though the wheels of British engines, by reason of the higher weight limit, are still of heavier build.

The use of solid coupling rod ends has made it possible in many cases to dispense with axle-box wedges in their guards. This simplification originated in England and has the advantage that engine drivers or shed men are unable to interfere with the adjustment of the motion. But it necessitates a good fit and the replacement of liners as soon as they are slightly worn out and beginning to give birth to longitudinal lost motion. It was to be feared that the outside crank of the Walschaerts gear, as it used to be forged solid with the driving pin, would make it impossible to adhere to this arrangement and especially to the round ends of coupling-rods. Happily, there was soon introduced a practical and strong form of detachable crank which permitted the rods to be disconnected without introducing the use of brasses and wedges or cotters.

As long as inside cylinders were in use, the Stephenson valve gear was practically the only system to be met with. With outside cylinders having the valve chest between the frames, it forms a good and neat arrangement having the only inconvenience that the valves and their gear are not so easily accessible as when outside, a consideration which does not seem to have been deemed of any importance on British railways up to a very recent period, at least as long as slide valves were solely used. Modern powerful locomotives having outside cylinders are fitted with outside Walschaerts gear; inside and outside gears are necessary for engines having four cylinders when the cranks are not at 180 deg., and for three cylinders. This type of gear, used for half a century on the Continent, has become the standard as well in the United States as in Europe. Its extraordinary success is less due, I think, to its capacity as regards the phases of steam distribution and to its having only one excentric, as to the facilities it gives for placing the valve chests horizontally above the cylinders without the use of a rocking shaft. Marshall's and Joy's valve gears permit the same disposition, but they have a great disadvantage for a locomotive, as the relative vertical motion of the driving axle and the centre line of cylinder resulting from the action of the spring gear on the road disturbs in some degree the phases of the distribution.

British engines are well arranged as regards wear and tear and cost of repairs; I could mention many facts, but they are all covered by what has been said above: they are generously built. For instance, the coupling pins have often a diameter almost twice as great as on some continental engines at least as powerful, and all bearings are as largely proportioned as possible.

The wheel base of the bogies is generally less than is usual elsewhere, save on American engines, not of the latest types. It is 6ft. 6in. as an average, instead of 7ft. 2in. on French and often 8ft. on German locomotives, and contributes to the compactness of British engines. However, there is a tendency to increase these figures, especially on engines having outside cylinders. Thus this wheel base is 7ft. 6in. for the new engines of the "Nelson" class of the Southern Railway.

The laterally sliding bogie, controlled by springs and derived from the Adams type, may yet be found under many engines, but the use of the swing motion truck of American pattern is spreading. Some locomotive engineers in Great Britain do not care for this system, which they consider too lively. The sliding bogie, also used by many continental railways, is, on the contrary, too stiff, and the regularity of its working depends on thorough lubrication, which is not always obtained. When that is the case this type of truck may offer to lateral displacement an initial resistance of more than two tons. I know cases in which it has been found that no lateral displacement had taken place at all between two hoistings of the engine for change of wheels at a year interval, possibly because the springs were too stiff. This type of bogie may suit short engines, like the 4–4–0 British engines, particularly if it is not much loaded, but for powerful engines the swing motion truck appears to have a great superiority. Its initial resistance to lateral motion may be as small as desirable, but it increases quickly (more or less according to the length or to the initial angle of the links) as the movement increases and soon becomes greater than with the sliding truck. The American truck offers the characteristic of being absolutely independent of all lubrication, and is indifferent to possible neglect in the maintenance. If I am not mistaken, the Lancashire and Yorkshire Railway was the first to introduce it in England. In order to avoid the "lively" effect, if it is feared when the suspension links are long, the lateral motion may also be controlled by coiled springs (Italian Railways), but they are unnecessary when the suspension links are well disposed and proportioned.

Radial axle-boxes for trailing or leading uncoupled pairs of wheels are now out of use and Bissells have taken their place with advantage.

In new "Mikado" and "Pacific" locomotives, the trailing axle has the boxes outside as in American engines, which is a good disposition, as it avoids their being heated by reason of their proximity to the lower part of the fire-box. This trailing axle, on "Pacific" engines, always heavily loaded, should have wheels of the largest possible diameter, to avoid heating on long-distance express trains.

The boilers of standard British locomotives have grates of moderate dimensions on which the coal, of good quality, is burnt with a thickness generally superior to what is usual in foreign engines. With a strong draught they can burn per hour more fuel per unit of grate area, and a simple comparison of the figures cannot give a complete idea of the steaming capacity. The combustion is rationally effected, thanks to brick arches (used now on engines of all countries), deflecting plates and air inlets through especially designed apertures in fire-box doors. Those railways which have followed regularly this mode of firing have been able to make the most of their engines and to keep locomotives of moderate dimensions longer in service.

The tubes are comparatively short, but the barrel is very often of a greater diameter than on continental engines of larger size, and that is an important point. Thus a diameter of 5ft. 10in. is often reached instead of the 5ft. 5½in. on large foreign engines. I consider this as a very good and desirable arrangement because, if the number of tubes (supposed of the same diameter) is not greater, they are a little further apart from centre to centre, a condition favourable to the strength of the back tube-plates; if, on the contrary, the pitch is the same, it is possible to use more tubes. The weight is not much increased if, as is the case with standard British engines, the barrel is short.

Now, the heating surface of relatively short tubes is more efficacious than that of long tubes. When the tubes are more than 15ft. long, for example, the evaporation from the last 10ft. is very small. We can conclude from what precedes that a British engine having tubes of 13ft. to 14ft., as on the 4–4–0, and even on some 4–6–0 locomotives, has a smaller heating surface on the paper, but a more effective one. One cannot object too much to the tendency of some drawing-offices to increase to the maximum the number of tubes for a given diameter of barrel. The draughtsman is pleased to have been able to place the maximum number of tubes in the boiler, but the running shed or repair shop foreman is not so pleased, knowing how difficult it is to maintain in good working order a fire-box tube-plate having the minimum of thickness between the tubes.

The copper fire-box has advantages and does not need nursing as the steel one does, but the metal is so soft that the tube-plates are incapable of standing, without damage, many successive expansions of the tubes when they leak or when retubing is necessary. They need, after a while, frequent and not altogether easy repairs. Steel fire-boxes have made progress in Europe, but an intermediate device, originated in Germany, seems to be rational. The whole fire-box is copper with the exception of the tube-plate, which is made of steel and is riveted to the lower part of the front plate, the seam being protected from flames or hot gases.

It is to be noticed that some engineers or makers have kept to the very special practice of fitting the boilers with longitudinal stays, screwed and bolted to the two tube-plates. This arrangement is never to be seen on foreign engines; it may possess the advantage of preventing any bulging out of the fire-box tube plate, but given the difference of expansion between the stays and the tubes, it is open to some drawbacks. It seems doomed to be given up with the use of superheaters by reason of the disposition of the tubes.

It is a rather singular fact that the Belpaire fire-box has been given up in most countries, even in its native land—for at least twenty years—excepting in Great Britain, where it was adopted later, and where it seemed to be less suitable by reason of the narrowness of the cabs and the more restricted field of visibility.

British, as well as foreign makers, began by placing the exhaust nozzle very high, even at the foot of the chimney quite on top of the smoke-box. It has been successively lowered till the upper part of this nozzle is now generally placed at about the same height as the centre line of the barrel, and sometimes even lower. But with the increasing height of boilers, the chimney is lengthened downwards inside the smoke-box and the distance between the lower part of its cone is not as great as it seems at first sight, but this distance is still sometimes about 2ft. On continental locomotives, and particularly on French engines, the nozzles are generally higher. Though no complete theory of the induced draught by the blast has ever been presented, I think that in this case British practice is preferable.

American makers have arrived at the same conclusion, though starting from a contrary state of things. In their first engines, the exhaust nozzles were quite low and they have successively raised them towards the centre line of the barrel. This seems to show that it is the optimum disposition, and that some continental builders are yet influenced by the early practice in this respect.

Very few British engines are fitted with a variable exhaust nozzle, a standard feature of the continental locomotive, and they don't need it, the firing not being operated according to the same methods, and because the grade and kind of fuel do not vary in the same proportion. On the Continent, the same tender may receive together briquettes of very good quality, run-of-mine, and fine coal, and the draught must, if possible, be varied to suit such different fuels. On very long runs also, when, towards the end, the fire is dirty, the driver is able, thanks to a variable exhaust, to obtain a stronger draught. British railways do not, perhaps, fully realise the facilities and simplifications which are derived from the high grade of fuel they have at hand. On the other hand, some foreign railways are mistaken when using, for certain services, low grade coal not really fit for a locomotive if they can get better fuel; all expenses included, that practice is never economical.

Whatever be the quality of the fuel, it must be acknowledged, as we have said, that it is burned very methodically on British engines and with the minimum of smoke. It is this efficiency of combustion, united with a strong draught, that allows the use, for a given service, of smaller grates than in other countries, and this is partly the result of air being admitted above the coal. The drivers make good use of the blower, which is put on as soon as smoke appears—indeed, even on the road when the regulator is shut. The engines have also always a full head of steam. British railway companies pay, with reason, a great deal of attention to smoke abatement and the drivers are looked after to this end.

The British engineer, thanks either to a certain ideal or to an exclusive taste for mechanical achievements, or to the fact that the railways, since their

beginning almost, were more in the public eye than elsewhere, the stations being so accessible and the lines penetrating into the heart of large cities, have always attached importance to the appearance of their locomotives. They like neat and symmetrical engines, and the locomotive superintendents never lost sight of what I should call the architectural point of view, mostly doric, *i.e.*, good outside appearance owing to a happy union of simplicity, strength, and well-balanced proportions, or to the extreme care of eliminating from the view sundry details, such as sand-boxes, rods, external pipes, &c. It is not such a secondary conception, as this kind of refinement proves an ideal very far from pure utilitarianism, and if ever British engines were deprived of these national characteristics, they would certainly lose their originality and some of their interest. Formerly limited to Great Britain, this practice has rather spread, and has not been without influence in effecting the much neater appearance of many engines of Western Europe. An engine, as well as other productions of human industry, may have its elegance, but it must be made on simple lines giving the necessary value to the important part of the structure. But for those who doubt the evolution of British ideas with regard to the design of locomotives, it is interesting to compare (apart from the increase of power) the engines built even in the beginning of the century with present tendencies. This fact is particularly illustrated by the comparison of simple and four-coupled engines having inside cylinders and very low running boards hiding even the coupling rods, with some modern engines of the 4–6–0, 4–6–2, or 2–8–2 types, still keeping as much neatness as possible, but with all their working parts outside, Walschaerts valve gear and a raised running board giving access to the motion.

Tenders are generally low and comparatively long; always carried on six wheels or two bogies. The four-wheeled tender disappeared with the first out-of-date locomotives. On some lines, fitted with numerous water troughs, they are of small capacity by comparison with the distances run without stops, but recent engines are coupled to large bogie tenders, for example, on the Southern Railway, where the last built have a capacity of 5000 gallons. They are designed in the same style as the engines, making a real complement to them and are not simply, as in America, special cars having no other purpose than to carry water or fuel. They differ from the tenders of other countries in not having their water tanks disposed in horseshoe form with the coal loaded in the middle, on the bottom. The top of the tank is inclined towards the platform, and the coal is maintained by a metallic partition with a central aperture allowing the fireman to shovel it forward. He has not to raise the coal, which, thanks to the arrangement, does not slip on to the engine platform. An excellent arrangement which should be followed elsewhere. With this disposition, the tank, taking up all the length of the tender, has the advantage of a more equal division of the weight on the axles, nearly always equally distant when there are three of them.

Tenders of British design are generally distinguished by the arrangement of the tanks, brought between the frames below the foot-plate level. This makes it possible to lessen the height of the tender from rail level, for a given capacity, but the construction of the tanks and of the underframe is more complicated. New tenders have been recently built with the whole of the tank above the frame.

The general workmanship leaves nothing to be desired, but this is so general now in Europe that it is scarcely to be mentioned. I may note, however, some refinements contributing to the good appearance of the engines and tenders. For example, the rivets of outside plates, such as those of smoke-boxes, cabs, panels of tenders, very smooth and well trimmed, are countersunk; the coating and painting of external surfaces are always finished and maintained with great care.

Is it necessary to recall that the engines are kept in very good condition and working order, and generally with remarkable cleanliness? That has always been a tradition in British railway circles.

(To be continued.)

Iron and Steel Institute.

No. I.

The annual meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers, London, on Thursday and Friday, May 3rd and 4th. At the opening meeting on the morning of May 3rd, when the retiring President, Mr. F. W. Harbord, was in the chair for a short while, there was an unusually large attendance of members, possibly by reason of the fact that Mr. Charles M. Schwab, President of the American Iron and Steel Institute and President of the Bethlehem Steel Corporation of America, was present to receive the Bessemer Medal. Subsequently, as usually happens, the attendance dropped off, according to the particular paper read and discussed, but judging by the considerable signs of conversation that reached the lecture theatre from time to time from the entrance hall, it was evident that the opportunity was being taken to carry on informal discussions outside. In this way the attendance during the meetings varied considerably. Taking the meeting throughout, however, a larger number of members put in an attendance than has been the case at one or two of the more recent meetings.

The report of the Council was presented to the meeting and taken as read.

The Hon. Treasurer, Professor H. C. H. Carpenter, then presented the accounts for 1927, and again called attention to the tendency, which has manifested itself during the past two or three years, for the expenditure to rise and the income to remain stationary or even to fall off slightly. As a matter of fact, there is a deficit for 1927 of £879, and Professor Carpenter pointed out that this revealed a serious position for the Institute. The expenses of the *Journal* are the biggest item, and for 1927 show an increase of about £700 over what may be regarded as the normal expenditure on this account. Therefore, the Council has decided to ration the *Journal*. Another matter which is seriously affecting the financial position of this and other technical institutions is the refusal of the income tax authorities to refund the income tax on the General and Special Funds of the Institute. So far as the Iron and Steel Institute is concerned, this represents £134 for 1927, but the matter is being fought in the courts, and the Council, through the Hon. Treasurer, expressed the hope that this sum may yet be recovered. The most serious trouble of the Council, however, is as regards the membership, which, although only down by a matter of £75 as regards subscriptions, is causing the Council much concern, in view of the fact that since 1921 there had been a drop of 245 in numbers. With a view to dealing with this position, seven

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committees have been set up throughout the country, each presided over by a member of the Council, to endeavour in the great iron and steel producing districts to bring about an improvement in the membership. Professor Carpenter concluded by expressing the belief that it will be possible to bring back the membership to its normal dimensions and even to increase it, as many of the causes which at any rate have brought about the present position may be expected to disappear, the principal of them, of course, being the very difficult times through which the iron and steel industry has been passing.

The report and accounts were then unanimously adopted, and Mr. Benjamin Talbot, the President-elect, took the chair.

On the motion of Sir Robert Hadfield, F.R.S., a hearty vote of thanks was accorded to Mr. F. W. Harbord for his services as President during the past year.

The President, in taking the chair, said that he regarded the presidency of the Institute as the highest honour which he had ever received, except one, and that was the Bessemer Medal, which he ranked in front of it. He expressed the belief that the flag of the Institute and of the industry would be kept flying if every individual member assisted to that end.

Continuing, he said that his first duty was to present the Bessemer Medal to Mr. Charles M. Schwab, who was President of the Bethelehem Steel Corporation and also President of the American Iron and Steel Institute. In Mr. Schwab there was the unusual and rare combination to find in one personality, the three qualities of scientific knowledge, technical ability and administrative capacity linked with force of character which had enabled him by his own ability and energy to forge his way to the leading position in the iron and steel industry of the United States. Mr. Schwab was born in Williamsburg, Blair County, Pa., on February 18th, 1862, and started his distinguished career in the Edgar Thomson Steel Works of the Carnegie Company in the somewhat subordinate capacity of driving stakes at a dollar a day. In a period of seven years he had risen to the position of chief of the engineering department of the Carnegie Company. The great Homestead Steel Works plant, designed by him, and erected under his supervision, was arranged to be a practically continuous mill so that the raw materials went in at one end and the finished products came out at the other. In 1892 Mr. Schwab was appointed superintendent of the Edgar Thomson Steel Works, and, after a very difficult period in the history of labour in the American steel industry, was also appointed superintendent of the Homestead plant. In the year 1896 he was made a member of the board of managers of the Carnegie companies, and in the following year was elected President. It would be an encouragement to our young men to know that at the age of thirty-five Mr. Schwab had become the chief executive officer of what was then the greatest manufacturing company in America. The problem in the United States at that time was the manufacture of more steel, better steel and more rapid production. In this, Mr. Schwab achieved the best practical results, and the presidency of the Carnegie Company was the reward he gained. As President he made the position of his company stronger and stronger. Smaller concerns were combined until the company attained an impregnable position in relation to raw materials, to modern equipment and to skilful management, with Mr. Schwab foremost amongst the world's practical steel makers at the head of the company. Whilst the technical side of the business was progressing in a manner unprecedented in the history of the world, the commercial results obtained at that time were unsatisfactory, owing to the competition between rival firms, and it was realised that if further commercial development on economic lines was to be made possible, a fusion of interests between the larger companies was necessary. It was chiefly due to the ability of Mr. Schwab, who was the intermediary between Mr. Carnegie and the other parties to the bargain, that a consolidation was effected, and the United States Steel Corporation came into being, with Mr. Schwab as President. Thus at the age of thirty-nine he became President of the world's greatest corporation, and his organising genius was responsible for the most gigantic working force and the most complete industrial system ever put together in the service of a private corporation. Mr. Schwab resigned his presidency of the United States Corporation after three years, and obtained a controlling interest in the Bethlehem Steel Corporation. The Bethlehem plant at that time was largely engaged in the manufacture of munitions. Under the control of Mr. Schwab, it had become one of the most magnificent steel works in the world, but at the present time the manufacture of munitions took up less than 5 per cent. of the productive capacity of the plant. It was conducted on entirely independent lines, and was second only to the United States Steel Corporation. The capital of the Bethlehem Company amounts to 569,633,335 dollars, and its various works have an ingot capacity of something like 7,910,000 tons per annum. Apart from his contribution to the advancement of the manufacture of iron and steel, this country was under a great debt of gratitude to Mr. Schwab for the very eminent services he rendered to the cause of the Allies in the Great War in the production of munitions, and, later, when our mercantile marine was being weakened by the activity of enemy submarines, by the tremendous efforts he made as Director-General of the Emergency Fleet Corporation to provide ships for the conveyance of the American armies, stores and equipment to France at the most critical period in the war.

The President added that he had received a cable from Mr. Farrell, President of the United States Steel Corporation, saying that he was unable to come over to the meeting, but, at the same time, expressing the gratitude of the industry in the United States at the high honour conferred on his colleague, Mr. Schwab.

Mr. Schwab, in accepting the Medal, after speaking of his fifty years' service in the manufacture of iron and steel, said that he regarded the Bessemer Medal as ranking far above the wealth or position that he might have attained. He had often dreamed of the Bessemer Medal, but never imagined that it would come to him either at his time of life or at the hands of Mr. Talbot, whom he had known so many years ago when he paid visits to America. Whilst the American industry as a whole was animated by feelings of greatest goodwill towards the British industry, there was no American who bore a warmer love or feelings for his British brothers than he did. It had not been his intention to speak of the war period, but as the President had mentioned it he would say that when the Bethlehem works was placed at the disposal of Great Britain a fortune so vast as to be almost unmentionable was offered to him to decline to serve the British nation in that way, but his reply had been that there was not enough money in the whole of Europe to make him take that course. He had received undue kindness at the hands of the British people and had carried out billions of dollars' worth of business with Great Britain without a contract and without anything in writing, and yet had never had one word of dispute or unpleasantness at any time. He was one of those in America who openly believed and stated that whilst the Americans were not able to contribute any man power to the Great War it was their duty to contribute money, and he was not in sympathy with the people who were endeavouring to extract dollars and pounds

from the men who stood together for the preservation of civilisation and mankind. He had to go back to America again in a day or two, but he took back with him a happy heart, a heart overflowing with appreciation for the kindly remembrances of an old American steel master. As a citizen of America it would be his aim to do everything possible to promote friendship between that country and the British Empire, and he expressed the hope that the British iron and steel trade would become more prosperous than it had been in the past. It was to be hoped that our legislature would see its way to make it prosperous, and anything those in the industry in the United States could do to co-operate to make it so he was convinced would be done.

The President then delivered his presidential address, of which we gave a report in our issue of last week.

The first paper read was "Blast-furnace Data and their Correlation," by Mr. E. C. Evans and Mr. F. J. Bailey. We give below a "Summary of Practical Deduction" taken from the paper.

BLAST-FURNACE DATA.

1. From a study of over 120 blast-furnace operating results a method has been developed of correlating blast-furnace data on a common basis, which is in agreement with similar methods adopted in reheating furnace practice for the correlation of output and fuel consumption.

2. This method finally shows that, other things being equal, the greater the effective time of contact between the reducing gases and the ore before the hearth is reached, the lower is the fuel consumption.

3. Among the factors influencing effective time of contact are :—

(*a*) Slow driving of the furnace.
(*b*) Preparation of the burden prior to charging.
(*c*) Suitable methods of charging.
(*d*) Adoption of suitable furnace lines.
(*e*) Use of coke of suitable quality.

4. The carbon required for external heat losses in the hearth is of a much higher order than has previously been considered to be the case, and it therefore follows that slow driving of the furnace is the least economical method of obtaining effective time of contact, since the external heat losses per ton of pig iron produced per unit of time are increased proportionately.

5. The carbon required for meeting external heat losses in the hearth zone is inversely proportional to the hearth diameter, so that in furnaces having the same effective time of contact between reducing gases and ore and the same production of iron per square foot of hearth area per hour, small hearths are less economical than large hearths.

6. A general study of the results available indicates that furnace practice in different countries has developed on lines covered by economic considerations of the following general character :—

(*a*) In countries using local ores with a very wide market for pig iron of constant quality with high labour rates and large capital resources, the tendency has been towards large hearth diameters with moderate rates of driving reckoned as pounds of carbon per square foot of hearth area per hour.

(*b*) In countries largely using imported ores of high quality with a market considerably in excess of immediate post-war capacity and with limited capital resources, the necessity of increasing outputs with furnaces of moderate size has resulted in extensive preliminary treatment of the ore with a view to the attainment of very high rates of driving per square foot of hearth area per hour.

(*c*) In countries whose market conditions for pig iron are of a constantly varying character the tendency has been in the direction of furnaces of moderate size operated at moderate rates of driving.

If the furnace efficiency be measured by the extent of preliminary reduction of the materials in the shaft, after due allowance has been made for all factors involved, practice in the various countries is comparatively equal.

7. The quality of the iron, in so far as it is represented by the percentage of silicon, has an important effect on the hearth heat consumption.

8. The influence of dry blast has been investigated, and results indicate not only improved thermal efficiency at the tuyeres, but that a further saving exists, due possibly to an increase in the effective rate of reaction between the gases and ore.

9. Results obtained indicate the necessity of investigation into :—

(*a*) Improved refractories in blast-furnace practice, to allow of reduction of external cooling losses, with maintenance of suitable furnace lines.
(*b*) The influence of the quality of the ore on the efficiency of reduction in the upper portion of the furnace and consequent effect on fuel consumption in the hearth.
(*c*) The nature of the influence of moisture and/or hydrogen on blast-furnace reactions.

Mr. A. K. Reece, opening the discussion, said that, whilst the authors had done good work in collecting so much information from 120 furnaces, the information suffered from the fact that those furnaces were made up of good, bad, and indifferent types, so that it was impossible to draw definite conclusions from the information. Moreover, although the authors had drawn certain conclusions which might be warranted, it was not stated in the paper how they had been arrived at, and it was difficult to accept the formulæ put forward unless it was known how the figures were obtained. There was also a great number of assumptions in arriving at the formulæ. For instance, 350 lb. of coke was assumed for the coke not burned at the tuyeres, but no one had a right to assume a factor like that as being constant for all blast-furnaces, because there was great variation in the amount of carbon not burned at the tuyeres. On the whole, however, the results arrived at by the authors were in agreement with his own practical experience.

Mr. D. Sillars said that the authors had proceeded on the basis of frequency curves, but he did not think there was sufficient justification for proceeding by that method, having regard to the fact that 120 furnaces all working under different conditions were considered. It would have been far better to have dealt with smaller groups of the same type of furnace instead of lumping together 120 furnaces operating under different conditions, because, if the maxima and minima as well as the average curves had been given, some rather astonishing results would have been shown. All the changes which had been referred to in the paper were treated as if they had a straight line relation to one another, but that was very far from the fact. At the same time, whatever might be thought of the individual conclusions, there was no doubt that the authors had attempted to do a very difficult thing; they had attempted to blaze a trail through a jungle which had not hitherto been explored, and whatever success or failure they might have achieved they were to be thanked for it.

Mr. E. H. Lewis said that it must be remembered that this was only a preliminary report, and the criticism that only 120 furnaces had been dealt with could easily be remedied by blast-furnace people sending in more results for the authors to work upon. The difficulty was indeed to get sufficient results. From his own experience, however, of applying the authors' statistical method to his own results he had found it very helpful in seeing when anything was wrong.

Mr. Evans, replying to the discussion, said that, although Mr. Reece had complained of the paper because he did not know how the figures were arrived at, they were justified by the fact that they did fit in with Mr. Reece's own practical experience. Mr. Sillars was quite correct in saying that some extraordinary results would be obtained if maxima and minima were taken from the curves, but the curves were only intended to be an actuarial average and could be applied to test the efficiency of blast-furnace operation in any individual case. Mr. Lewis had been associated with this work from the outside and had given information of the greatest value.

The next paper was one entitled "The Reactivity of Coke," by Messrs. J. H. Jones, J. G. King and F. S. Sinnatt.

We quote below the introduction to the paper, which gives an idea of its scope.

THE REACTIVITY OF COKE.

The properties of coke are being investigated from a number of aspects at the Fuel Research Station, Greenwich, and one programme of research has led to the evolution of an empirical method for the determination of the "reactivity" of coke towards carbon dioxide. Apart from the more fundamental work of investigating the mechanism of the reaction, a large number of cokes supplied by the National Federation of Iron and Steel Manufacturers have been examined. The present paper is intended to show the differences which exist between such cokes, and is offered as a progress report. Work on the explanation of the reaction phenomena is proceeding, and will be included in a further paper when the data are more complete.

The proposed method for the determination of reactivity values has been described in a Fuel Research Board Technical Paper, and the present paper contains only the essential features.

The ractivity of coke may be defined as a measure of the velocity of reaction between coke and carbon dioxide, the term "combustibility" being reserved for the reaction between coke and oxygen. In the method adopted, "reactivity values" are measured by the volume of carbon monoxide produced when a definite volume of carbon dioxide is passed at a constant rate over a definite volume of sized coke maintained at a constant temperature. Conditions have been arbitrarily fixed so that the values for what may be termed "normal" high-temperature cokes lie in the sensitive portion of the scale.

The conditions adopted for the method are :—

Size of coke	Through 10-mesh and retained by 20-mesh I.M.M. sieve
Length of coke measured with thermo-couple in position ..	7·5 cm.
Internal diameter of tube ..	1·4 cm.
Temperature of coke	950 deg. Cent.
Volume of carbon dioxide used for each determination ..	100 ml.
Rate of passage of carbon dioxide	5 ml. per min.

Mr. King, who introduced the paper, said that since the paper had been written thirty more cokes had been investigated and the results fell into line with those in the paper. He admitted that the conclusions were not very clear, but the paper was to be regarded purely as a progress report of the work that was being done, and he hoped the discussion would give many ideas for the continuance of the work.

Opening the discussion, Dr. R. Lessing said that the reactivity of coke was a matter which had given rise to a great deal of discussion during the last five or ten years, and it was still a moot question whether the reactivity of coke, *i.e.*, the reactivity of coke to the attack of CO_2 as against the combustibility of coke by oxygen or air, was to be desired or not. In fact, the paper did not make it quite clear whether the best coke should be highly reactive or not. The paper, however, put forward another item in the train of evidence as to the difference in cokes which were used for blast-furnace and metallurgical work. In the past, cokes had been regarded merely as so much carbon mixed up with so much inert material, and there had only been an empirical attempt to gauge their quality as regarded physical strength. Such tests, however, were now being elaborated, and the question of chemical composition and physical strength had to be correlated. The great difficulty was to correlate them with actual practice, and the one factor which influenced the reactivity and combustibility and even the physical character of coke to a great extent, was the ash in the coke. The monetary value of a reduction of ash in coke had been calculated and shown to be very considerable, and his own work indicated that cutting down the ash to 3 or 5 per cent. might make a difference of something like 6s. or 7s. per ton in the cost of pig iron. These calculations, however, merely took into account such matters as the slag produced, the cost of disposal, the limestone required and so on, but could not possibly take into consideration the incidental advantages, such as faster driving of the furnaces, the greater purity of the iron made, the degree of interaction between the coke and the ore to complete combustion, and so on. It was obvious, therefore, that the question of the inorganic constituents of the coke needed to be studied with very much greater care than had been the case in the past. His own conviction was that the difference in reactivity which had been shown by the results obtained at the Fuel Research Station and by the work of others, were closely bound up with, if not entirely due to, the ash in the coke.

Mr. E. C. Evans said that the method of determining the reactivity of coke devised by the Fuel Research Board should be investigated, and if the results obtained by it could be correlated with those obtained by other methods, it might be possible to devise a simplified test which would be of considerable use to the industry.

Mr. D. Sillars said that the differences between one coke and another shown in the paper were practically those which were well known in the works. Although the authors were right in deciding upon 950 deg. Cent. as their reaction temperature, so far as their work was concerned, he wondered if they had ever conducted any experiments at a very much higher temperature, say, 1400 deg. Cent., to find out whether, as one would almost expect, with a rising temperature there would be a greater difference between the reactivity of one coke as compared with another than was experienced at the lower temperature. The point was that blast-furnace operation took place at a slightly increasing temperature, and the results obtained under those conditions might well be different from those obtained at the temperature adopted by the authors.

The authors will reply to the discussion in writing.

The final paper at the morning session on May 3rd gave a complete description of the new plant of the Appleby Iron Company, Ltd., and was written by Mr. A. Crooke and Mr. T. Thomson.

THE APPLEBY IRON COMPANY, LTD.

The works of the Appleby Iron Company are situated near Scunthorpe, in North Lincolnshire. The selection of the site was due to the presence of the bed of ironstone known as the Frodingham bed, a deposit which was known and worked in the time of the Roman occupation of Britain, as is shown by traces of their smelting operations. Blast-furnaces, however, were not built until about 1860. The Appleby Iron Company, Ltd., formed in 1874, blew in their first furnace about 1877, and carried on the manufacture of pig iron until 1910, when the plant was closed down. At that time it consisted of four blast-furnaces, one 62ft., one 65ft., and two 75ft. high. In 1912 this plant was acquired by the Frodingham Iron and Steel Company, Ltd., which had for many years carried on successfully the manufacture of steel sections. It was desired to extend operations to include the manufacture of steel plates, in the belief that the sale of these two products would thereby be mutually promoted. Preparations were made for additions to the blast-furnace plant and for new steel works in 1914, but it was not until 1917 that the work was actually put in hand.

Unfortunately the shortage of men and materials at that time was so great that the works were not completed before the trade slump in 1921. Operations then had to be suspended and were not resumed till 1926. The first of the new blast-furnaces was blown in during January, 1927, and at the same time the first steel was made and the first slabs and plates rolled.

Four blast-furnaces were taken over from the original Appleby Company, with their equipment of stoves, calcining kilns, blowing plant, &c. These furnaces are hand charged. Two blast-furnaces of modern design, Nos. 5 and 6, were added. These are 80ft. high and the charging gear is of the inclined hoist and bucket type. They have ten 6in. hearth tuyeres and five 4in. bosh tuyeres, four rows of copper coolers, a steel bosh jacket which is sprayed with water, and ten rows of cast iron stack coolers.

The stove equipment for the two furnaces consists of six stoves, each 20ft. in diameter by 100ft. in height, of the two-pass Cowper type. The gas is taken from the top of each furnace by two downcomers into a large plain dust catcher. It is then passed through a gas cleaner of the steel mattress type, consisting of five units, capable of rough cleaning 60,000 cubic feet of gas per minute. The gas from this plant is used at the stoves and boilers. The cooling water for the furnaces is supplied from an overhead ferro-concrete tank of 75,000 gallons capacity which also supplies the cooling water for the old furnaces.

The blowing plant consists of two vertical steam blowing engines, each capable of blowing 18,000 cubic feet per minute at 10 lb. pressure, and two steam turbo-blowers, each capable of blowing 28,000 cubic feet per minute at 12½ lb. These, with their necessary Lancashire boilers, are situated together, and may be termed the old plant, although the turbo-blowers have been installed since 1915.

The gas-driven blowing plant consists of two gas engines, each capable of blowing 28,000 cubic feet per minute at 12½ lb. pressure, and two gas engines, each capable of blowing 40,000 cubic feet per minute at 13½ lb. pressure.

In the same house is placed the power plant, supplying the electrical requirements of both the blast-furnaces and the steel works. The installation comprises five gas engines, each coupled to a 1500 kVA alternator running at 100 revolutions per minute and one 3750 kVA turbo-alternator. The steam turbine is supplied with superheated steam at 150 lb. per square inch pressure from water-tube and Lancashire boilers, all fired by blast-furnace gas.

The clean gas for the gas engines is supplied by a cleaning plant of the Halberg-Beth type. This has four units, each capable of cleaning 1½ million cubic feet of gas per hour.

A part of the blast-furnace gas cleaned in the Halberg-Beth cleaning plant is passed through boosting fans and transmitted through an overhead steel tube 4ft. in diameter and about 1800 yards long to the steel works. This steel tube is used as the support for the insulated electric cables between the power-house and the steel works.

Steel Works.—The open-hearth plant consists of one mixer of 500 tons capacity and four tilting furnaces, three of 250 tons and one of 300 tons capacity. The hot metal is charged into the mixer in the casting bay and is tapped in the charging bay, the metal being distributed to the furnaces by two 50-ton hot metal cranes.

The furnaces are fired by producer gas generated by a battery of Kerpely revolving grate producers, fitted with automatic feeders and levellers and separately blown by turbo-blowers.

The rolling mills consist of a slabbing mill, a 10ft. plate mill, and a 7ft. plate mill. The ingots on cars are shunted by a locomotive into a building where they are stripped by an electrical overhead crane. The stripped ingots on the cars are pushed through into the soaking pit bay. In this bay are three gas-fired soakers, each having an ingot capacity of 100 tons, and three Gjers soaking pits without heating, each having an ingot capacity of 160 tons. The ingots are charged by two overhead cranes,

each capable of handling ingots up to 20 tons in weight. These cranes also draw the soakers and deposit the ingot direct on to the slabbing mill rack, which is extended into the soaking pit bay.

The slabbing mill is an electrically driven reversing mill, with rolls 42in. diameter and 9ft. 6in. long. The mill is driven through machine-cut helical pinions and spindles having universal coupling boxes, by a motor capable of exerting a torque of 20,000,000 inch-pounds up to 48 revolutions per minute and with a rating of 15,200 horse-power from 48 revolutions per minute to 100 revolutions per minute. A separate hydraulic accumulator is provided in a closed circuit with the balancing cylinders. All the motions of the manipulators on each side of the mill rolls are electrical.

The run-out rack from the slab shears is continued through into the reheating furnace bay. There are four reheating furnaces of the vertical soaking pit type, with sliding roof doors. Three of these furnaces are built to take slabs up to 8ft. long, and one is made to take slabs up to 12ft. long. They are served by two overhead chargers, one of 15 tons and one of 5 tons capacity.

Leading from the reheating furnace bay are three bays, the first two of which contain the 10ft. plate mill and the third the 7ft. plate mill. The 10ft. mill receiving rack extends into the reheating furnace bay and receives the slabs direct from the charger. A rope-driven chariot receives slabs from the charger and conveys them to the receiving rack of the 7ft. mill.

The finished plates are passed through a plate mangle on to the receiving side of the cooling bank. The mangle has nine rolls 18in. in diameter by 12ft. 6in. long, and is of specially massive design. The cooling bank is 115ft. long and 95ft. wide and has two sets of chain conveyor type skids, each set being divided into three sections. The skids are arranged so that all the plates on one or more sections are moved towards the delivery rack at one operation. Inserted between these skids are two hydraulic turnover gears for plate inspection. Over the mill stands, a 40-ton overhead crane is provided. From the cooling bank delivery rack the plates are passed on for shearing.

The driving motors of the two plate mills are placed in the same portion of the centre bay of the mill bays. This portion is specially closed in and forms the main electrical sub-station of the steel works, besides housing the main mill motors. Here terminate the main cables from the power-house. The sub-station also contains two motor generator fly-wheel sets, three motor converter sets, and two banks of static transformers. Each motor generator fly-wheel set has one 3000 B.H.P. alternating-current motor and four direct-current generators each of 4500 B.H.P. maximum rating, and one fly-wheel of 36 tons weight. The alternating-current motors are fed at the voltage generated, 6600 volts, and the eight generators are coupled to the three mill motors in such a way as to take advantage of the energy of both fly-wheel sets for any one of the mill motors. The three motor converter sets are each of 750 kW capacity and provide direct current at 220 volts for auxiliary mill and crane reversing motors. The static transformers provide alternating current for the continuous running motors throughout the steel works plant. The lighting system is entirely separate from the power system and operates at a voltage of 110.

From the inception of the plant it was decided to exploit the use of blast-furnace gas to the fullest possible extent in order to reduce to a minimum the purchase of external fuel. Coke oven gas not being available, it is not economically possible to save the coal necessary for open-hearth furnaces, nor is it expedient to save the coal used in locomotives. For all other purposes requiring fuel blast-furnace gas is used. The total external fuel used at the steel works is about 4 cwt. of coal per ton of ingots produced.

To secure the most efficient use of the blast-furnace gas the plant is well supplied with instruments. The gas is metered separately at each point of use, but not for each individual unit. The amount used is continuously recorded for blowing engines, power engines, boilers, stoves, reheating furnaces, soaking pits, and metal mixer.

The President said that the paper constituted a brief description of a really modern installation, which was very similar to the best to be found in America.

Mr. Charles M. Schwab said that he often wondered how we in this country managed to design such plants with our small outputs, compared with the large American outputs. As a matter of fact, he did not feel that America deserved any credit for their plants, seeing that they ran for 365 days in the year on one size of rods or sheets or whatever the product might be. If they could not get costs down under those conditions, they would be very bad engineers. One outstanding feature in American practice was that blast-furnaces were being designed for a minimum of 800 tons of pig iron per day, and usually 1000 tons per day was obtained. As a result of that it had been possible to cut down the direct labour costs on blast-furnaces to 35 cents and less per ton. The next great improvement was in the size of American open-hearth furnaces, which were now being made very much larger than before, and capable of taking 250 to 300-ton heats, dividing the heats in the ladle and getting great economies. He felt that the chief changes in years to come would be in the continuous rolling of sheets, for large blast-furnaces and large open hearths. He had received a cable from America that morning stating that his mills were running to 90 per cent. of their capacity, and the thing he was looking to was to get the extra 10 per cent. After all, the iron and steel industry in America was very poor. It was not making much money; indeed, he was ashamed to say that in the steel business, with its vast investment of something like six thousand million dollars, they were not making much over 5 per cent. After fifty years' experience of the iron and steel industry, and in the perfecting of costs and the manufacture of steel, he felt that the perfection of methods of distributing the steel so as to get a better price for it was the great need of the immediate future. The direction in which work would have to be done in that respect would be, first of all, to protect the home markets for the chief consumption and then to distribute collectively in some manner that would comply with the law and yet give the advantage of selling at a price that would give a profit on the capital invested. Those were directions in which attention would have to be paid in America as well as in Great Britain and elsewhere, and whilst it was exceedingly interesting to listen to technical discussions, his own mind was constantly running on the question of where a better price was to be obtained for steel.

Professor Henry Louis asked the authors to amplify a remark made rather casually in the paper to the effect that for the blasting of ironstone, liquid oxygen was being used. He would like more details of that as one who was, he believed, the first person to attempt to use liquid oxygen for that purpose in this country. Technically, the results were satisfactory, but commercially they were not. He had some recollection of the Cleveland ironmasters carrying out a series of experiments with liquid oxygen, but they did not obtain any commercial advantage from them. Liquid oxygen had been used with very great advantage in the iron ore mines of Lorraine, and apparently, from what the authors had said, it was being used with success in the Lincolnshire ironstone mines.

The authors will reply in writing.

The first paper to be taken on Thursday afternoon was one on "The Fatigue Resisting Properties of 0·17 Per Cent. Carbon Steel at Different Temperatures and at Different Mean Tensile Stresses," by Mr. H. J. Tapsell, of which we give the author's own abstract.

THE FATIGUE-RESISTING PROPERTIES OF CARBON STEEL.

A review of the behaviour of a mild steel under fatigue stresses over a practical range of temperatures has been attempted. It is based on fatigue experiments carried out at the National Physical Laboratory on normalised 0·17 per cent. carbon steel, in order to obtain information concerning the effect on the fatigue limit due to a variation of the mean stress in a tensile direction.

The experiments were carried out in a Haigh machine under direct pulsating stresses, applied at the rate of 2400 cycles per minute. Fatigue limits were determined at different mean tensile stresses and at temperatures up to 500 deg. Cent., the limits being based on endurances of 10^7 cycles. It has been shown that the practical use of the results obtained depends on their correct interpretation. For such an interpretation a knowledge of the yield points and of the limiting creep stresses at different temperatures is necessary. This information is given in the paper, and from the results of the experiments made it has been possible to correlate the factors concerned in the fatigue behaviour of the steel at high temperatures.

Dr. W. H. Hatfield said that the paper, together with one issued by the Department of Scientific and Industrial Research on the nature of creep of Armco iron, gave a lot of data of the kind badly needed at the present time in view of the state of mind of the engineer, as a result of the manner in which creep studies had been put before him. The author, in speaking of the fatigue range of his material at ordinary and at high temperatures, stated that the stresses must have a definite relationship to the yield at ordinary temperatures or to the limiting creep stress at the high temperatures. Dr. Hatfield suggested that in that the author was speaking of one and the same thing, and when that was realised the whole position from the standpoint of the designing engineer would be clarified. It did not seem to be appreciated as much as it should be that, in the first place, fatigue failure did not occur until the material was stressed within the range at which plastic deformation took place. It was also necessary to determine in a ready manner the stress under which a steel would behave as, at any rate, a practically elastic body. It was absolutely essential that as quickly as possible some information should be provided for the use of engineers which would give a value comparable with the yield value at ordinary temperatures and which should have some relationship to the fatigue range of the material; in his own laboratory work had been done on creep from the practical standpoint of the industry, and it had been decided to postulate that there should be an extension not exceeding ·5 per cent. in the first twenty-four hours and no further measurable increase over the next forty-eight hours. That gave something which was comparable with the yield point with which the value at ordinary temperatures was associated. It might be said that he was postulating conditions of test which were impracticable, but he was not. As a matter of fact, it had been shown to be quite practicable at enhanced temperatures. Using that method of test, he had come across a fact which had surprised him very much in making a comparison of wrought iron and mild steel. The amazing fact came out that the limiting creep or yield stress at 200 deg. Cent. with wrought iron was 6·6 tons. At 500 deg. it had fallen to 3·2 tons. With mild steel having a carbon content of ·27 the value was 12 tons at 400 deg. and 6·9 tons at 500 deg. Cent. That was an astonishing disparity of values between wrought iron and mild steel.

Mr. T. P. Colclough thought that the work described in the paper would become of fundamental importance in relation to high-pressure boiler plates, and he asked whether it would be possible for the author to continue his investigations on rolled plate. The elastic limit given in the paper was considerably higher than that frequently put forward as necessary by Lloyd's engineers and Admiralty engineers for 17 per cent. and 35 per cent. carbon steel and so on, and his own experience was in accordance with the figures in the paper. At the same time, his experience was that the limit of proportionality in 1in. rolled bars which had been taken for the purpose of investigation was very close to the yield point. The same results, however, did not apply to material rolled in the form of plate which had its work done more in a unilateral direction. Therefore it would be interesting if the author would continue his work on rolled plate. In the tests carried out on the 1in. bars the reversals of stress had been at the rate of 40 per second, but in the case of boiler work the reversals on stress had nothing like that rapidity. It would be of value to engineers and manufacturers if they had an idea of what the limiting stresses and reversals were when the stresses were applied at a very much slower rate.

Dr. W. Rosenhain said that it was beginning to be thought that these endurance phenomena, of which resistance to fatigue and creep were examples, had a common factor which depended on the mechanism by which the metal underwent deformation and fracture and that that mechanism ultimately was not very different in the different forms of failure which could be caused. It depended perhaps more upon the temperature and the rate of deformation to which the metal was subject than upon anything else, but it was necessary to be careful. There were some who thought that at ordinary temperatures and even at high temperatures there were stresses which, however long applied, would not produce fracture or deformation sufficiently serious to be dangerous, but that was not yet definitely known. The whole thing was a question of relative temperature range. In all such inquiries metallurgists must be careful of one factor, namely, the influence of chemical agencies. McAdam, in America, had called attention to the effect of corrosion, and his own opinion was that there might be other than ordinary corrosive influences; the influence of the temperature at which the tests were carried out might have a much greater effect on some materials than upon others. It was interesting to hear that the Sheffield laboratories were doing work on the high temperature properties of steel, and it was to be hoped that the results would be published as soon as possible.

The Author, referring to Dr. Hatfield's test of ·5 per cent. elongation for twenty-four hours and no further elongation for forty-eight hours, said that he had not tried that method, but was not sure that it would give correct results because at the lower temperatures above the yield point there was a considerable elongation the moment the load was applied and then a considerable elongation afterwards, whereas with the limiting creep stress the elongation at the moment of applying the load was extremely small and the increase was also extremely small afterwards, so that there was a possibility that at the higher temperatures a stress would be given very much above the limiting creep stress given in the paper, whereas at the lower temperatures it would probably be somewhere between the limit of proportionality and the yield point.

Dr. Hatfield asked what period of time was required to produce the limiting creep stress under the author's method of testing.

The Author said that it might take three or five months, but the point was that when he approached the limiting creep stress the elongation from the start was practically all elastic. Therefore he suggested that Dr. Hatfield's method would give a result considerably above the limiting creep stress at the higher temperatures and somewhere between the limits of proportionality and the yield point at the low temperatures, as a result of taking the elongation as ·5 per cent. throughout the whole temperature range. The reply will be extended in writing.

A paper on "The Properties of Nickel Steels with Special Reference to the Influence of Manganese" was then read by Mr. J. A. Jones. The author has summarised his results as follows:—

NICKEL STEEL AND MANGANESE.

The properties of nickel steels containing carbon 0·2 to 0·55 per cent. and nickel 3 to 12 per cent. have been examined, with special reference to the effect of manganese.

1. The critical ranges of these steels have been determined. Ac_1 is lowered by about 10 deg. Cent. for each 1 per cent. of nickel. In nickel steels with 3 to 5 per cent. of nickel, cooled at a rate of 4 deg. Cent. per minute, the Ar_1 point is lowered by an amount varying with the manganese and carbon content from 25 deg. to 30 deg. Cent. for each 1 per cent. of nickel.

2. In nickel steels with low manganese contents there is no advantage in increasing the nickel beyond 6 per cent., on account of the limitation imposed on the tempering temperature by the lowering of Ac_1. For a similar reason with higher manganese (0·8 per cent.) no advantage is gained by exceeding 4·5 per cent. of nickel.

3. The effect of manganese up to 0·8 per cent. on the critical ranges of nickel steel is small. An increase of manganese from 0·4 to 0·8 per cent. in steels with about 4 per cent. of nickel causes a fall in Ac_1 of 3 deg. Cent. and a similar fall in Ar_1 when the rate of cooling is about 4 deg. Cent. per minute.

Chromium produces a decided rise in Ac_1 even when present in small quantities; 0·22 per cent. of chromium raises Ac_1 by 7 deg. Cent., though it has little effect on Ac_3, Ar_3, or Ar_1.

4. The effect of manganese in maintaining increased hardness of 3 to 4 per cent. nickel steel at slow rates of cooling becomes most evident when 0·5 per cent. of manganese is exceeded. When both manganese and chromium are present the influence of the chromium in this respect is nearly twice as great as that of manganese.

5. An increase of manganese in 3 to 4 per cent. nickel steels leads to an improvement in the elastic limit and yield point without loss of ductility. A sudden marked improvement becomes evident at a manganese content which is greater the larger the section treated.

6. A nickel steel which, on account of its section, has received inadequate hardening may, after tempering, show the desired hardness and tensile strength; but when it is compared with a steel which has been efficiently hardened and subsequently tempered to give the same tensile strength, the mass effect will still be evident in lower elastic limit, yield ratio, elongation, reduction of area, and impact figures.

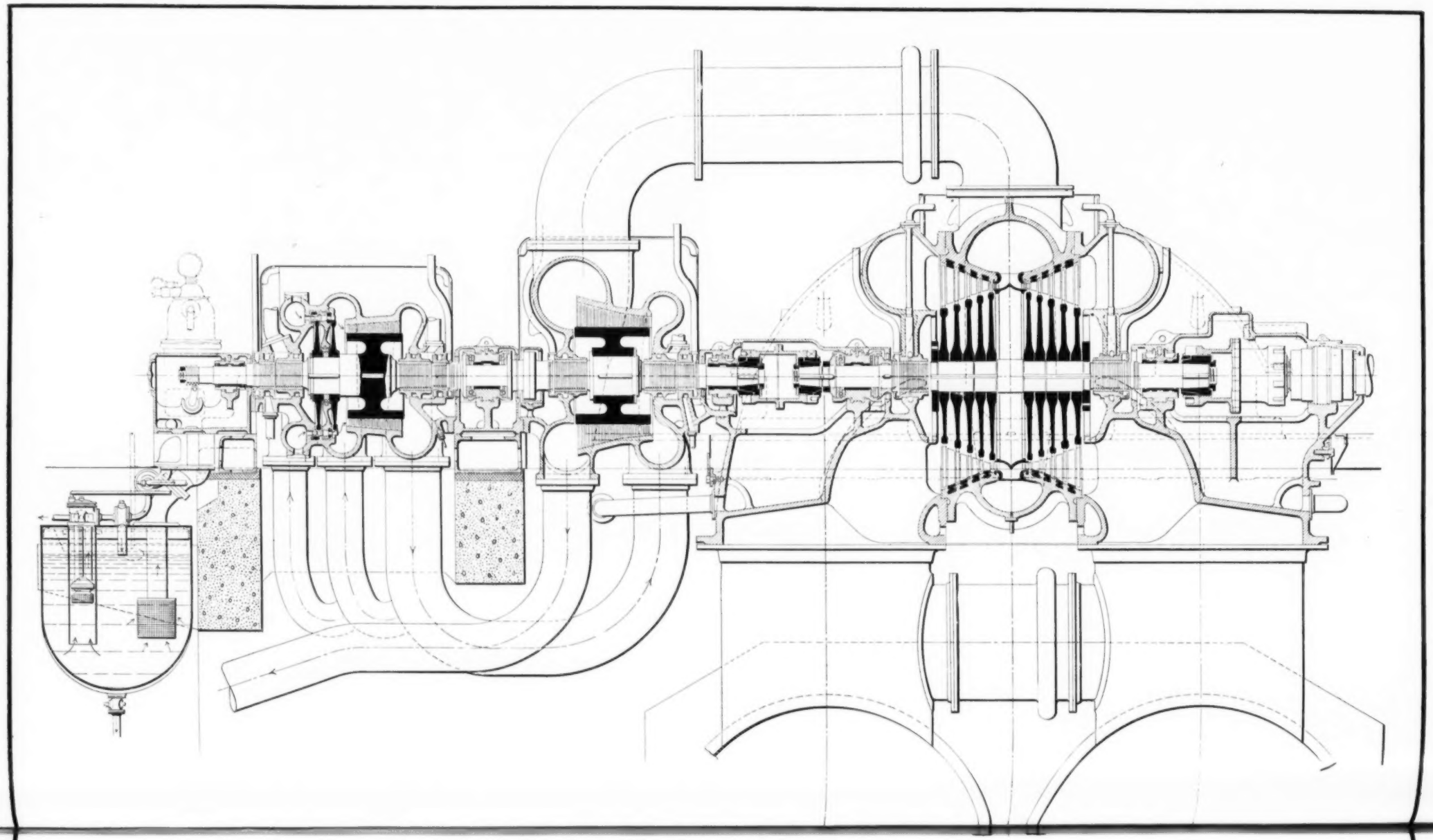
These effects are due structurally to the separation of ferrite during hardening, and to the incomplete suppression of the pearlite change.

7. Manganese has a marked influence on the mass effect in 3 to 4 per cent. nickel steel. A low-manganese steel will not harden satisfactorily even in very small sections. The amount of manganese necessary to secure adequate hardening varies with the size of section treated, but in no case should it be less than 0·5 per cent. A manganese content of 0·8 per cent. is an advantage in securing good tensile properties in large masses, and is preferable to an increase in carbon content above 0·4 per cent. On the other hand, a very high manganese content involves susceptibility to temper brittleness, which has to be guarded against in heat treatment.

Mr. T. N. Service, opening the discussion, said that

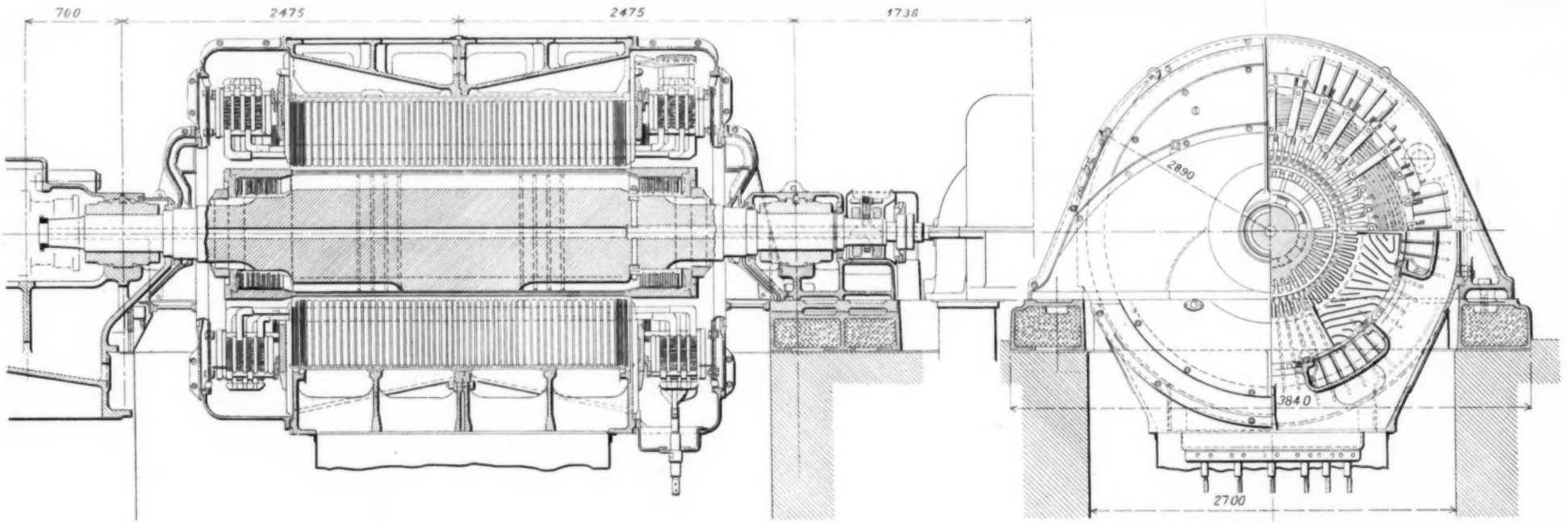
20,000-KILOWATT STEAM TURBINE AND GENERATOR AT ROTTERDAM

BROWN, BOVERI AND CO., BADEN, ENGINEERS



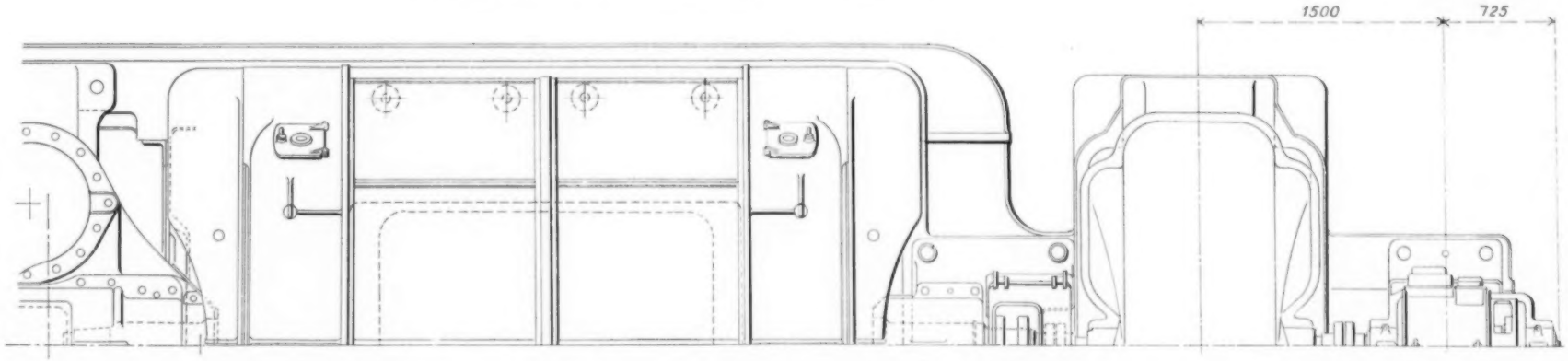
A LONGITUDINAL SECTION THROUGH 20,000 kW TURBINE.

A LONGITUDINAL SECTION THROUGH 20,000 kW TURBINE.



B. LONGITUDINAL SECTION THROUGH 20,000 kW ALTERNATOR

C. CROSS SECTION THROUGH 20,000 kW ALTERNATOR.



D. PART PLAN OF 20,000 kW ALTERNATOR, WITH BLOWER AND EXCITER.

UNIV OF KY

the author's work confirmed that which he himself had done up to the limits of mass mentioned in the paper, but the results did not apply to larger masses. He took exception to the statement in the paper that the manganese content should not be less than 0·5 per cent., because in making nickel steel pinions it was customary to have less than 0·5 per cent. manganese and to get the results asked for, viz., high elongation and high Izod figures. It was true that there was a certain amount of ferrite in the structure, but it was not sufficient to affect the mechanical tests. He had also tried higher manganese content, keeping the nickel and carbon the same, and his experience was that in taking transverse tests, as was necessary with pinions, the reduction of area, the elongation, and the Izod figures were reduced, although when only length tests were taken the figures agreed with those obtained with the lower manganese content. Hence the statement that the minimum manganese content should be 0·5 per cent. should not be allowed to pass. The amount must vary according to the circumstances and the particular test which the engineer specified.

Mr. A. P. Hague agreed with Mr. Service as to the varying percentage of manganese, and said that from ·4 to ·55 is better than from ·55 to ·8, which latter one would infer from the paper to be the best. In making pinion forgings it was necessary to have an Izod figure of 35 foot-pounds, but if the manganese was about ·8, there was very great difficulty in getting that result, whereas if the manganese was down to ·4 it was possible to get an Izod figure of as much as 60 foot-pounds.

Dr. W. H. Hatfield agreed that the industry could not accept 0·5 per cent. of manganese as a minimum, and he suggested to the author that, prior to publishing his paper, he should have gone to Sheffield and Glasgow, and had a talk with Mr. Service and himself and one or two others, when he would have had explained to him the inadvisability of putting such a limit forward. There was one point the author had not envisaged which was of very great consequence, viz., that when nickel or chromium was put into steel it was done because the steel was to be hardened and tempered, and it was the fact that if the manganese was run as high as the author suggested, there would be a great likelihood to cracking, which must be avoided at all costs.

Professor J. H. Andrew said that the author had shown clearly that if a steel was tempered at a temperature which was slightly within the Ac range, there was an increased hardening, but he would like to ask the author whether he had any figures to show the effect of manganese and nickel on the width of the Ac change, and also whether he had any theory of his own to put forward to explain the hardening which he got when he heated up to a temperature just within the Ac_1 range.

Mr. Jones, replying to the discussion, said that he thought he had made it clear in the paper that his minimum of 0·5 per cent. manganese was based solely on the question of mass effect, and he did not think that any results could be brought forward which would show that from the point of view of mass effect 0·4 per cent. manganese would be better than 0·8 per cent. He suggested to Mr. Hague that the Izod figures he had mentioned were not due to the deleterious effect of the manganese but to its effect on the rate of cooling and temper brittleness. The same thing applied to Dr. Hatfield's remarks with regard to cracking. He realised that an increase in the manganese content would involve some difficulties with regard to cracking, but, again, he reminded Dr. Hatfield that his suggested minimum of 0·5 per cent. was based solely on the question of mass effect, and he proposed to put forward some further results shortly which showed that the same effect occurred in forgings up to a wall thickness of 10in. to 12in. when the manganese was low.

A paper by Mr. A. B. Everest and Dr. D. Hanson on "The Influence of Nickel in Iron-Carbon-Silicon Alloys containing Phosphorus" was then taken. The authors reach the following conclusions:—

NICKEL AND FERROUS ALLOYS.

Phosphorus increases the hardness of the iron, increases its tendency to chill, and renders it difficultly machinable.

In the absence of chill, nickel produces its normal hardening action. Under conditions likely to produce chilled iron, nickel counteracts the chilling effect of phosphorus.

The microstructures show that phosphorus tends to reduce the influence of nickel on the iron. More nickel is required to produce a given result in the presence of high phosphorus, where there is any tendency to chill, than would be required in the presence of lower phosphorus.

Colonel N. T. Belaiew, referring to the statement in the paper that some of the phosphide areas were surrounded by dense pearlite, said that very dense pearlite might simply mean that the orientation of the pearlite grains in that particular area was different from that of the other areas. That would account for what the authors had called attention to.

Dr. F. Wust (Dusseldorf) said that he had done some work on steels of the nature discussed in the paper, and had found that the addition of nickel made the iron very grey. It, however, had a very high tensile strength, of the order of 60 kilos. to 70 kilos. per square millimetre. It was possible, he thought, by working along the lines indicated in the paper to make a new material particularly suitable for aero-engine cylinders.

Dr. Hanson said that the object of the work recorded in the paper was to study the effect of nickel on commercial cast irons, and it was only one stage in a very much larger investigation. The work had been carried very much farther than had been indicated in the paper, and it had been found that the beneficial effect of nickel was only brought out when the silicon content was rather abnormally low.

The final paper on May 3rd was one on "The Effect of Silicon on Tungsten Magnet Steel," by Mr. J. Swan. The author gives the following summary and conclusions:—

MAGNET STEEL.

The following remarks apply to a magnet steel of normal composition—that is, one containing about 6·0 per cent. of tungsten, not more than 0·74 per cent. of carbon, and 0·0 to 0·6 per cent. of chromium.

1. It has been shown that the "spoiling" of tungsten magnet steel with the usual silicon content of 0·13 per cent. or under by annealing above the Ac point is due to the gradual formation of free tungsten carbide, which is at the most only slightly soluble in austenite at ordinary hardening temperatures, so that the steel loses in available carbon and tungsten contents.

2. The tungsten carbide formed segregates to a marked degree on prolonged soaking, about twenty hours at 980 deg. to 1000 deg. Cent. being required to produce geometrically shaped crystals of appreciable microscopic size.

3. A silicon content of about 0·25 per cent. and above retards to a remarkable extent the carbide segregation, but does not prevent its formation, since loss in coercive force still occurs on annealing.

4. Silicon up to 0·59 per cent. has no harmful effect on the magnetic properties; it probably has a slight beneficial effect.

5. For the same coercive force as is given by a 0·5 per cent. steel a silicon content of 1·0 per cent. gives a lower remanence by about 1000 units.

6. The magnetic properties of three steels containing silicon after various heat treatments are given.

Conclusion.—When the fact was discovered that a relatively small amount of silicon retarded, or, as it was at first thought, stopped the formation of tungsten carbide, it was hoped that higher percentages would possibly eliminate the "spoiling" effect produced by reheating the steel for rolling or forging. This has not proved to be the case, so that it is still necessary for magnet steel manufacturers to use a maximum reheating temperature for rolling of the order of 1200 deg. Cent. if the utmost efficiency from tungsten steel is desired. It is true that 1·0 per cent. of silicon reduces the loss of coercive force on annealing or soaking by about a half, but this is offset by the inferior all-round magnetic properties of the steel, although a steel with lower carbon, tungsten, and chromium contents than those of the author's test pieces would be expected to give a better result.

The results of a few tests suggest that in the silicon steels the loss due to ageing is considerably less than in steels without an appreciable amount of that element.

The effect of the silicon in retarding tungsten carbide segregation forms a basis for the explanation of the larger volume change on hardening tungsten die steel, which results in the progressive contraction of the bore of circular drawing dies on repeated quenching, a property so much desired by users.

Mr. S. A. Main said that work of this character must be carried out in a very systematic way, and one must be very careful before hanging such rather important results upon such a very slender percentage of silicon as that mentioned. If the analysis had been taken on the bars as well as on the ingots, it would have been desirable, because on occasions one found that the two analyses did not always agree. The differences in that case might be of a sufficient order to create a doubt, although he did not say that would necessarily be so.

The author said that both the original ingots and the bars were analysed. He admitted that it did seem rather a tall order to say that an increase of silicon from ·13 to ·25 had the effect stated, but the metallographic investigation seemed to point to that; moreover, since preparing the paper he had had one or two further steels made with that percentage of silicon, and they showed the same phenomenon, viz., that there was no appreciable tungsten carbide segregation when the steels were annealed.

The meeting was then adjourned until the following morning.

The Chemical Properties of Crystals.*

By Professor CECIL H. DESCH, D.Sc., Ph.D., F.R.S.

FROM the fact that several of the May Lectures delivered before members of this Institute have dealt with the structure and properties of crystals, and others with the nature of the atom, we may conclude that these subjects, once only of interest to a small number of students, are now recognised as of importance for the study of practical metallurgy.

The whole tendency of modern physics and chemistry is to dwell more and more on the atomic structure of matter. It is strange at this time to recollect that little more than twenty years ago a prominent school of physical chemists urged that atomic conceptions should be allowed to fall into the background, and that the science should be refounded on a basis of thermodynamics only. A less happy forecast could hardly have been made. Every further discovery has emphasised the fundamental importance of atomic ideas, and has justified those far-seeing men who, early in the last century, used the conception of the atom to bring order into the facts of chemical composition. We can only conceive of the structure of matter, whether solid, liquid, or gaseous, in terms of atoms and molecules. Modern physics, by giving us the electron, has revealed a structure of a finer type within the atom itself, but this has only enhanced, and not destroyed, the value of the original conception. The view expressed by Lucretius, that all matter was composed of minute particles widely separated, has proved to be the true one, although the old philosophers could hardly have guessed that the particles would prove to be so minute, and the distances between them relatively so enormous, as in the systems of electrons and positive nuclei which we picture as constituting matter to-day.

Metals, which form the special objects of our study in this Institute, are composed of crystals, but the rarity of measurable crystal faces among them has greatly delayed the application to them of the classical methods of the crystallographer and mineralogist. When it was found that the diffraction or reflection of X-rays within a crystal made it possible to determine the arrangement of the atoms within it with a high degree of accuracy, a new means of investigation, more searching than any before known, was placed in the hands of the research worker, and nowhere has it proved of more value than in the study of metals. It can now be determined which are the planes in a metallic crystal that are most densely packed with atoms, and therefore most distant from their immediately adjacent planes having the same packing. As mechanical slip commonly occurs most easily in the direction of those planes, and along one of the most densely packed lines in that plane, the direction of slip in a given crystal may usually be predicted although certain anomalies still call for explanation.

The knowledge of the atomic arrangement within crystals has also proved of value in bringing order into the facts concerning their physical properties, such as the electrical and thermal conductivity, although this side of the subject has been less attractive to most workers than the study of deformation.

On the modern view of the atom, as a positively charged nucleus surrounded by electrons, in number equal to the atomic number of the element, and moving in orbits the shape and dimensions of which vary according to laws which are now well established, it is the outer electrons which determine the chemical properties. The most stable arrangement is that of an inert gas, such as neon or argon, and elements which can, by giving up one or more electrons, assume that arrangement are electro-positive or metallic, whilst those which can more easily reach the stable configuration by accepting electrons from elsewhere are electro-negative and non-metallic.

Atoms may be linked together by means of electrons in three different ways. The simplest is the transfer of electrons from one atom to another, in the formation of electrolytes. A sodium atom gives up one electron to a chlorine atom, so that both assume an outer structure like that of an inert gas, and a molecule of sodium chloride is formed. Or a pair of electrons may be shared by two atoms—that is, they may take up new orbits which enclose both nuclei. This is the usual manner of formation of organic compounds, but it is also characteristic of many inorganic compounds, such as solid carbon dioxide or beryllium oxide. Each of the atoms concerned contributes one electron of the pair.

Let us now turn to the crystal, the atoms in which are held together by forces of attraction, giving the crystal its cohesion, its resistance to tension and shear. At the same time there must exist forces of repulsion, so that the atoms maintain a certain mean distance from one another at a given temperature, and offer a resistance to uniform compression. When constructing crystal models, we commonly represent the atoms as spheres for the sake of simplicity and convenience, but we have to remember that their near approach in a solid may give rise to quite considerable deformation—a fact which is important for their chemical as well as for their physical properties.

The simplest type of crystal is represented by rock salt. Every sodium atom has lost an electron, and every chlorine atom has gained one, so that the crystal is not built up of atoms in their normal state, but of ions. The two kinds of atoms form two interpenetrating lattices of the face-centred cubic type, every sodium ion being equally related to six chlorine ions, and every chlorine ion equally related to six sodium ions. There are no molecules, and the structure is one of great simplictiy and high symmetry.

The simple electronic unions between atoms, whether of the electro-valent type as in rock salt, the covalent type as in beryllium oxide, or the co-ordinated type as in cyolite, do not exhaust the varieties of attraction in a crystal. There are cohesive forces even between uncharged atoms. As these are represented by a term in the well-known equation of state of van der Waals, they are commonly known as van der Waals' forces, but their origin is still obscure. They have been attributed to the distortion of the electronic orbits, but their origin is of less importance than their magnitude. Irvine Masson has shown that a mixture of argon and ethylene gases, which cannot be supposed to have any chemical affinity for one another, may be as much as 8·5 per cent. more compressible than a single gas. Such forces must play a considerable part in the cohesion of solids, in which the approach of the atoms is so much closer than in gases.

The molecule as we know it in liquids and in gases has disappeared in the formation of the rock salt lattice, but it does not follow that the molecule has no meaning in the solid state. Crystals of pure metals are regarded as built up of positive ions only, the liberated electrons being in a more or less free

* Eighteenth May Lecture to the Institute of Metals, delivered May 8th, 1928. Abridged.

condition, and being responsible for the electrical conductivity. Whilst at first sight simpler, the study of such lattices offers much greater difficulties from a quantitative point of view than that of crystals built up of ions of opposite sign. The space lattice of calcite is an ionic one, the ions being Ca and CO_3, the carbon and oxygen atoms in the latter ion being constantly associated in a way which recalls molecular union. Nothing has been said of the magnetic forces in the lattice, but it is obvious that there must be magnetic fields due to the moving electrons in the atomic orbits, and that forces between atoms may result, but this side of the subject is at present very obscure.

Lennard-Jones and Dent have recently calculated in detail the forces at a cube surface of a rock salt crystal. A charged ion outside the crystal would be attracted to the surface by a force which falls off rapidly as the distance increases. The van der Waals' forces, which may be exerted also on an uncharged atom or molecule, are smaller than the electronic forces near the surface, but they fall off less rapidly, so that at the distance of a few Angström units they actually exceed them. In addition, there are smaller forces due to the polarisation of a neutral atom in the electro-static field of the crystal. These several forces make it possible for atmos, ions, or molecules to attach themselves to the crystal face, more or less permanently. It will be clear that the attractions will be different, and possibly very different on different faces, partly owing to the varying closeness of packing, but also to the distribution of electronic charges. A cube plane always consists of alternate sodium and chlorine ions, but alternate octahedral planes consists only of sodium and only of chlorine ions. The chemical properties will clearly not be the same. What evidence have we that such is the case? I think the best evidence is that of the effect of impurities on the habit of crystals. Common salt normally crystallises in cubes, but in presence of certain substances, notably of urea, it forms octahedra. There is no question of a change of space lattice, but only of the relative development of different faces. If we suppose that urea is held or "absorbed" by the octahedral planes more readily than by cube planes, the former will be rendered less able to take up salt molecules during growth, and it has been established that it is those faces perpendicularly to which growth is slowest which develop on the crystal. The process has been watched in lead nitrate.

In general, in a lattice consisting of atoms of only one kind, the residual affinity will be least on the most densely packed atomic planes, but this is subject to certain exceptions.

All reactions which depend on adsorption at the surface must be dependent in a high degree on the size of the crystals. This is particularly true of reactions in which a metal or other solid is used as a catalyst in bringing about combination between gases, as in the synthesis of ammonia from nitrogen and hydrogen.

We may now consider the action of a chemical reagent, such as an acid, on a crystal of a pure metal. All the atoms are alike, so that the only differences between different planes are those of density of packing. Reagents which dissolve the metal do not, as a rule, do so equally in all directions. If they did so, a smooth surface would be etched equally all over, and would remain smooth. Actually, the surface is roughened, and examination under a sufficiently high magnification reveals a geometrical pattern of pits or "etch-figures" which evidently bear some relation to the internal structure of the metal. Iron gives a particularly clear pattern of cubes, and bismuth gives definite triangles. The problem of the nature of etch figures, which have been known for more than a century, is a baffling one. It is easy to understand that in so regular a structure as a space lattice, the reagent can penetrate in some directions more readily than in others, and if this were all the explanation would not be so difficult. It is, however, remarkable that quite different etching patterns may be obtained by changing the nature, concentration or temperature of the etching reagent.

That the rate of solution of different faces of a crystal was not the same has long been known. A sphere or cylinder of calcite immersed in acid develops crystal faces, just as when a similar mass of rock salt is immersed in water. Very dilute hydrochloric acid dissolves calcite without change of shape, but with higher concentrations crystal faces make their appearance, and it is remarkable that these are not always planes of greatest closeness of packing. In fact, whilst metals mostly give etch figures having simple forms, this is by no means true of minerals, especially of those of complex structure.

If we return to the simplest case of etch figures, that of cubic or octahedral pits on the surface of a pure metal crystallising in the regular system, we still find certain peculiarities which deserve attention. Granted that the attack follows definite lines or planes, why should the pattern recur at regular intervals, which are many thousands of times greater than the interatomic distances? Each etch figure starts from a point. It is impossible to attribute the origin to impurities or, as has sometimes been done, to convection currents in the liquid. A crystal of rock salt will develop perfect figures in a damp atmosphere, and it was shown fifty years ago that if a crystal of alum be allowed to grow under the microscope, and growth be interrupted by diluting the solution slightly, the distribution of the etch figures is quite similar to that on a crystal which has been exposed to the air. A well-formed crystal of quartz, etched with hydrofluoric acid, shows distinct etch figures widely separated from one another. These effects are not easily explained. They may be compared with the production of slip lines in the deformation of a crystal of a metal or a salt. The slip planes in a crystal, following the direction of the most closely packed planes in the lattice, are separated from one another by distances which are very large multiples of the interatomic distance. Why, out of such a large number of similar planes, should so few be concerned either in slip or in chemical attack? A basis of explanation has been suggested by Finlayson in the Faraday Society discussion on cohesion. Atoms in the same space lattice are oscillating, not at the same frequency, but with a range of frequencies from zero up to a maximum, and the theory of probability would suggest the occurrence of waves at intervals which would vary with the temperature and the applied stress. The suggestion is a promising one, and a similar explanation may be applicable to the formation of etch figures.

Leaving the exterior of the crystal for the present, we may consider the arrangement of the atoms in the interior when they are of more than one kind, as in solid solutions and in intermetallic compounds. The effect of foreign atoms in solution in distorting the space lattice and thereby hindering slip, so increasing the hardness, has been dealt with very fully by recent writers. Foreign atoms may enter into a solid solution in more than one way. They may replace the atoms of the original metal one by one, causing comparatively little change in the lattice. This is most likely to occur when the two kinds of atoms are similar in chemical character and also in volume, as in the pair gold and silver, which can form a continuous series of solid solutions, the space lattice changing its dimensions to a small extent without any profound alteration in its character. It is a controversial question whether such solid solutions tend to arrange themselves so that the distribution of the second species of atoms in the lattice is a symmetrical one.

Another type of solid solution is that in which relatively small atoms are packed into the interstices of the lattice, without very greatly altering its dimensions. This is supposed to be the case in austenite in steels, the carbon atoms being packed into the γ-iron lattice without causing much expansion, and without altering its symmetry.

Changes may occur during the cooling down of a solid solution of either of these types. The capacity of the space lattice for holding the second kind of atoms may diminish, so that a constituent is thrown out from solution, just as when a liquid solution has become supersaturated. In such a process, the varying properties of different planes within the crystal must again make themselves felt. Deposition will not take place uniformly throughout the crystal, but preferentially along certain planes, which are as a rule the most densely packed planes.

When metallic atoms are associated in the form of a solid solution, we may suppose that the constitution is essentially the same as that of a pure metal, metallic ions and free electrons forming a stable system with metallic conductivity, but without the properties of an electrolyte. The more closely similar the metals are, the less will the properties of the solution diverge from those of a single metal. As the properties become more dissimilar, chemical affinities become more important, until we pass through a succession of intermediate stages to such compounds as the metallic sulphides, which have ionic lattices and yet retain certain characteristics of the metallic state, such as electrical conductivity. The nitrides and carbides, which occupy an intermediate position, are supposed by some to be ionised, and by others to consist of atoms, without any distinct association into separate molecules. Attempts are being made in several quarters to distinguish by X-ray methods between ionic and atomic lattices, but there are still differences of opinion as to the interpretation of the results. There is no doubt that such discrimination is possible, but the matter is not yet ripe for a full discussion. So far, the X-ray evidence has not shown the presence of distinct molecules in alloys containing even well-defined intermetallic compounds, and so far it might be said that the compounds were built up of ions rather than of atoms united by covalent links, but it will be well not to dogmatise on this point. In all probability, there are gradations between true compounds and solid solutions.

The chemical properties of a compound or a solid solution will depend to a large extent on the closeness of packing. Although close packing is most familiar to metallurgists through recent work on metals, it is by no means invariable in crystals, and a special interest attaches to substances which are known to have comparatively open packing. Reagents can penetrate into an open-packed lattice with ease. An excellent example is that of graphite.

The mechanism of diffusion in solids has become more difficult to interpret since the information given by the X-ray method has been available. It was formerly possible to regard it as a simple change of place between neighbouring atoms, so that a foreign atom entering a space lattice could traverse it by a succession of single steps. As equilibrium in a solid solution would only be reached when the concentration had become uniform throughout, the force bringing about diffusion was regarded as osmotic pressure, and the laws of diffusion in liquids were applied to the case of solids. It proves, however, that in the ordinary space lattice there is not room for the change of place of neighbouring atoms, unless perhaps at temperatures approaching the melting point, when the amplitude of oscillation is large. And yet it is impossible for such reactions as the age-hardening of aluminium alloys by the deposition of particles from solution, or the separation of α crystals from a 60 : 40 brass on cooling, to take place without the transport of atoms through a space of many thousand atomic distances. Diffusion in crystals is an undoubted fact, although it does not always occur when a difference of concentration is present. Minerals which show a zoned structure, the equivalent of coring in alloys, have existed in rocks for millions of years without change, although the condition of equilibrium would presumably be one of uniform distribution throughout the mineral. Neither has diffusion been brought about in such minerals by artificial annealing. On the other hand, the halogen salts which are isomorphous may be made to diffuse into one another by heating a mixture of the powdered salts, and von Hevesy has found that silver iodide and cuprous iodide will interdiffuse to a depth of several millimetres in a few hours at 480 deg. As to diffusion in metals, there is an abundance of evidence, beginning with the striking experiments of Sir William Roberts-Austen on the diffusion of gold into lead, the accuracy of which has been confirmed by later workers. The law of diffusion is approximately fulfilled, and the process continues until the solid solution is saturated. It is remarkable, however, that experiments of this kind mostly fail when tried with a specimen consisting of a single crystal, and the process is more rapid in a fine-grained metal than in one of the same composition but of coarser grains.

Loosening of texture may be of importance for the chemical properties of crystals, even part from diffusion. It has long been known that a crystal of a hydrated salt may remain unaltered in dry air so long as the surface is perfect, but that a scratch will at once allow efflorescence to begin.

There are also reactions which consist in the passing out of atoms or molecules from the crystal, such as the liberation of oxygen by the heating of solid potassium permanganate. This has been observed to be essentially a boundary effect, and to be accompanied by a breaking down of the crystals—that is, the formation of new boundaries. The crystal itself is too closely packed to allow of the passage of oxygen outwards by simple diffusion.

To sum up. The chemical properties of crystals are, like their cohesion and their electrical conductivity, intimately bound up with the character of their space lattice. Since, moreover, it is the outer or valency electrons which are concerned in chemical reactions, the behaviour of the atom in the solid state is likely to be profoundly modified by its geometrical relations to its neighbours, on account of the deformation of the electron orbits. Looseness of packing is an important modifying factor, and it may be easiest to follow chemical processes in solids by observations on crystals having a more or less open structure, proceeding from them to the more perfect metallic and ionised types. The Bohr conception of the atom, and the perfected X-ray technique which is now coming into use, are the two means by which a solution may be reached of problems which have a high interest for practical as well as for theoretical metallurgy.

500 B.H.P. Oil-Electric Train.

THE oil-electric train, as applied to British railways, would seem to offer a field for development which falls between that of the already accepted steam or oil engine driven rail car and the quickly accelerated electric train, now so freely used for dense suburban traffic. With an oil-electric installation it becomes possible to employ a unit train of up to, say, 175 tons, with five to six coaches. As the power unit is installed in a separate compartment and is entirely electrically operated, the train can be driven equally well from either end, and difficulties in terminal working are thereby overcome. With regard to power output, such equipments may be well compared with that of a tank engine generally associated with passenger traffic of the type to which we have made reference. The available horse-power of the oil-electric generator set is greater than that of a tank engine at the lower speeds, and remains nearly constant at the higher speeds. In the article which follows we give a short description of a new 500 B.H.P. oil-electric train which, after undergoing an official inspection by London, Midland and Scottish Railway officials recently, ran a successful trial between Manchester and Blackpool. This train will, we are given to understand, be shortly put into service between Blackpool (Central) and Lytham.

THE POWER UNIT.

A general view of the train is reproduced in Fig. 4 on page 518. It is a four-coach unit, in which accommoda-

ELECTRICAL CONTROL EQUIPMENT FOR 500 B.H.P. OIL-ELECTRIC TRAIN

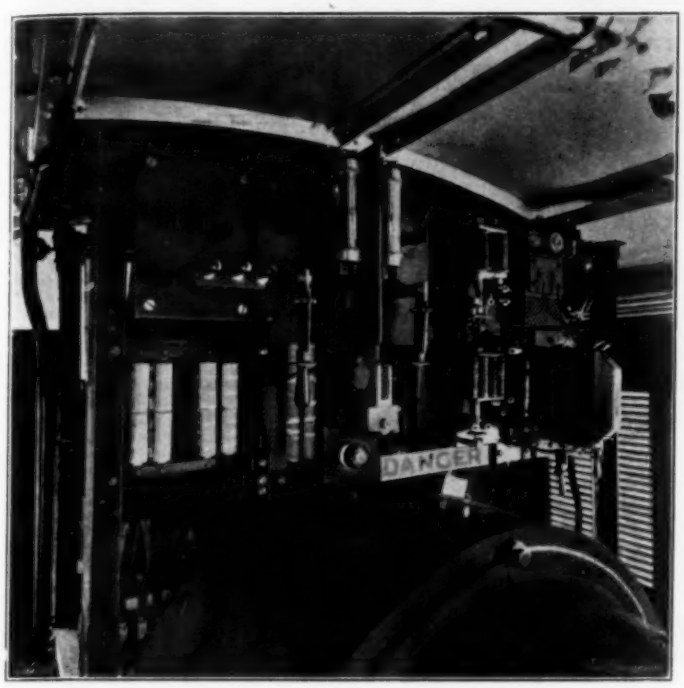


FIG. 1—DISTRIBUTING BOARD AND BATTERY CONTROLS

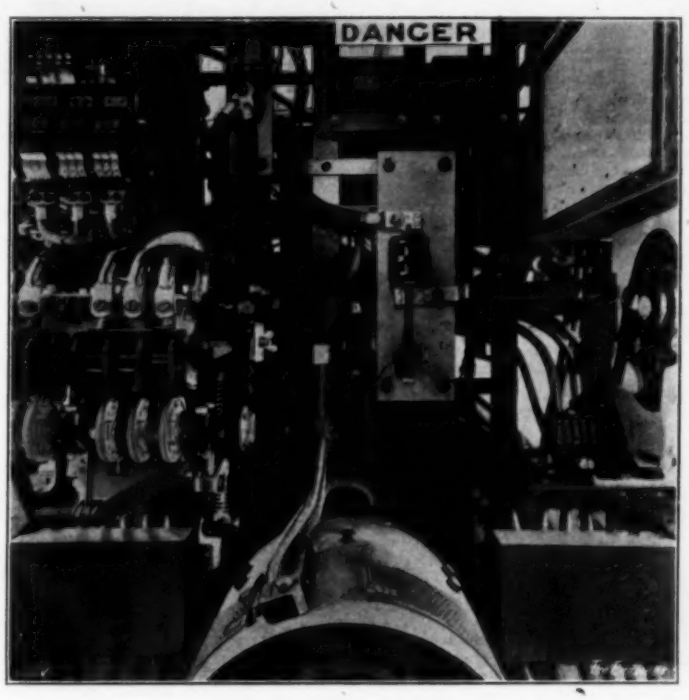


FIG. 2—SWITCHBOARD SHOWING CONTACTOR GEAR

tion is provided for thirty-two first-class and 255 third-class passengers. Its length over the buffers is 247ft. 3in. and the width of the coaches overall is 9ft. 6in., with a height from the rail to the floor of the coach of 4ft. 1¼in. Unloaded—that is, without passengers and luggage—the train has a total weight of about 144 tons.

The oil engine driven generator set is housed in the first coach forward of the luggage compartment. There is a length of about 22ft. from the forward partition of the luggage compartment to the front end of the coach, a small portion of which is partitioned off to form the motorman's compartment. At the opposite end of the train there is a similar driving compartment. Two views in the generator room are given in Figs. 5 and 6. They show respectively the front of the engine with the generator in the foreground, and the back of the engine as seen from the governor end of the set. As will be seen from these two engravings, duplicate fuel oil tanks, which contain sufficient oil for one day's service, are carried. There is also a tank for the engine cooling water, which is placed forward of the right-hand fuel tank. The tank is connected to a spiral tube type of cooler, which—as shown in Fig. 4—is arranged on the roof of the coach.

The engine is of an eight-cylinder unit of the Beardmore all-steel quick-running type, and was built at the oil engine works of William Beardmore and Co., Ltd., Parkhead, Glasgow. In general, the design is similar to that prepared by Mr. Alan Chorlton for the four-cylinder units built for the Canadian National Railway rail cars, described in the issues of THE ENGINEER for October 2nd and 23rd, 1925. For detailed features of construction, our readers may be referred to the first article above named.

The designed output of the unit we are at present considering is 500 B.H.P. at 900 r.p.m. Each cylinder has a bore of 8¼in. with a stroke of 12in. By the extensive use of alloy steels it has been possible to produce an engine having a weight of only 14½ lb. per B.H.P.

As our illustrations show, the engine crank case is mounted on a deep casting of special alloy steel, which forms the oil sump. The underside of this casting is bolted to the car sills, and the main casting is extended to bolt up to the frame of the direct coupled electric generator. The neat appearance of the monobloc steel crank case and the light aluminium covers which enclose the valve gear on the cylinder heads should be noticed. Each cylinder is furnished with two inlet and two exhaust valves with a centrally placed airless injection fuel atomiser. A primary oil pump maintains a low pressure on the suction side of the main fuel pump. There are four separate plungers, each of which serves two cylinders by means of a switch valve placed between the fuel pump delivery valve and the atomisers. The object of this valve is to time the injection of the fuel for the two separate cylinders served by the single plunger. As the injection period is timed, the engine output is controlled by varying the effective delivery stroke of the plunger by means of the earlier or later opening of a by-pass valve. Any surplus fuel is returned to the supply tank. The governor will be seen in the foreground of Fig. 6. It is of the totally enclosed type, and is so connected to the fuel pump controls that a small plus and minus speed variation is given at each of designed speeds of the engine. The engine is automatically controlled by electrical means. In Fig. 6 attention may be drawn to the four solenoid bobbins at the governor end of the unit. These solenoids, which are worked from the controllers, operate differential piston valves in an oil circuit, and by varying the oil pressure the governor is set in one of four different running positions. The engine is thus able to idle at 350 r.p.m., run at either 600 or 750 r.p.m., or at the maximum designed speed of 900 r.p.m., and at each setting the governor maintains a constant speed.

Lubrication is effected on the pressure system and the closed oil circuit includes a filter and oil cooler. "Monitor" valves are provided in both the lubricating oil and cooling water circuits, so that in the event of a failure taking place in either of these essential services, pilot lights are illuminated and give a warning in the driver's compartments. Arrangements are made whereby the engine can be stopped from either driving compartment, by energising a trip solenoid, which releases a shutter in the main air intake, and so cuts off the supply of air to the engine. Part of this electrically operated shutter is to be seen at the base of the vertical air inlet manifold, shown in Fig. 5. Fig. 6 illustrates the separate exhaust pipes, which are connected to a silencing tube which discharges the gases through a series of outlets carried through the roof of the motor coach.

THE GENERATOR BATTERY AND TRACTION MOTORS.

The generator and exciter, together with the complete controls, were supplied by the English Electric Company,

FIG. 3—DRIVING CONTROLS

Ltd., and were built at Preston. The generator is of the direct-current traction type, and has a maximum designed output of 340 kW on a one-hour rating, with an engine speed of 900 r.p.m. It is of the one-bearing type, and the exciter is overhung at the outboard end. The shunt winding of the generator is energised by the exciter or the battery according to the engine speed, and there is a series winding for decompounding which gives the unit a practically constant output characteristic at any speed of the working range. There is an adjustable resistance in the shunt field which is not used by the driver, but which can be set in the shed to meet special load conditions.

At engine speeds higher than 600 r.p.m. the exciter is designed to function as an auxiliary generator. It supplies constant voltage current for battery charging and for auxiliary loads, such as lighting, control operation and driving the brake exhausters, if necessary. The constant voltage characteristic is obtained by a decompounding series winding. The battery charging current is at a maximum at the 900 r.p.m. engine speed, and it diminishes with the speed until 600 r.p.m., when the battery floats across the exciter. There is an adjustable resistance in the shunt circuit for shed use. The normal designed output of the exciter is 7·75 kW at 120 volts, the voltage at maximum engine speed being 147 volts, corresponding to the voltage of the battery when fully charged. A 60-cell battery, supplied by the D.P. Battery Company, Ltd., supplies current at 120 volts for control operation. The 60 D.P. K.L. 9 type cells have a 112-ampère-hour discharge capacity on a five-hour rating. As mentioned before, the battery is charged by the exciter and an automatic battery cut-out of the standard type is fitted.

The two motors are of the London-Watford type, and they are mounted on the bogie at the trailing end of the power coach. Each motor is rated at 280 B.H.P. on the one-hour rating at 580 volts, with a gear ratio of 18 to 60. They are connected to the generator in permanent parallel through a remote control circuit breaker. There are field tap connections for weakening the field in two steps, and a remote controlled reverser which can be operated from either driving positions determines the direction of the train. The main control gear is mounted on a framework over the main generator and Figs. 1 and 2 show the battery controls and the contactor panel.

STARTING AND RUNNING CONTROLS.

The engine is started by operating the generator as a motor with battery current. After the battery switch is closed and current for general purposes is obtained, the generator field switch is also closed and then the starting switch. The battery current is limited by a resistance, and the starting switch is held closed until the engine fires. There is a spring release which opens the switch when the attendant releases the starting handle.

At either end of the train is the driver's compartment, which is shown in engraving Fig. 3. The driving handle on the controller can be moved into one of seven positions, which provide for the following sequence of operations :—

No. of position.	Description.	Operation.
1 ..	Off	Engine idles at 350 r.p.m.
2 ..	Transition	Engine speeded up to 600 r.p.m.: generator shunt field circuit opened; main circuit breaker closed
3 ..	1st running notch	Generator shunt field circuit closed
4 ..	2nd ,,	Engine speeded up to 750 r.p.m.
5 ..	3rd ,,	Engine speeded up to 900 r.p.m.
6 ..	4th ,,	First field tap
7 ..	5th ,,	Second field tap

In order to start the train the driver places his reverser key in the ahead—or reverse—position, and then moves the controller handle from position 1 to 2, at which he pauses a little while to allow the engine to speed up. He then moves the handle through positions 3, 4 and 5, and again pauses while the train accelerates. When a speed of 18 miles per hour has been reached the handle is placed in position 6, and position 7 corresponds to the normal running position with a speed of about 26 miles per hour. For inching and shunting, positions 3 to 7 may be employed. To shut off power, the handle is brought back to the off position, which slows down the engine to idling speed and shuts off power from the motors. The generator unit is only inspected when starting up in the morning and when shutting down after the day's run.

A "dead man's handle" is provided on the master controller, which, if released when running, applies the brakes and cuts off the power to the motors, at the same time reducing the engine to idling speed. The main and reversing cylinders on the master controllers are mechanically interlocked, so that the controller cylinder cannot be moved unless the reversing cylinder has been placed either in the ahead or reverse position. Only one reverser

key is supplied for the train. As engraving, Fig. 3, shows, there are the usual driving accessories provided, such as a screen wiper, a horn-operating handle and the pressure gauges for the brake system.

ROLLING STOCK.

In engravings Figs. 7 and 8 interior views of a first-class non-smoking coach and a third-class smoking coach are given. The stock was originally built for the Bury-Holcombe-Brook high-tension direct-current railway installation. Two third-class motor coaches of this stock, together with two third-class trailer cars, have been reconditioned and modified at the L.M. and S. carriage and wagon works, Derby, to meet the new requirements. In the leading coach there are fifty third-class seats non-smoking, and in the second coach eighty-five seats third-class smoking. The third coach has twelve first-class non-smoking and twenty first-class smoking seats, together with a further forty-five third-class non-smoking seats, while in the fourth or driving trailer coach there are seventy-five third-class smoking seats. Luggage compartments are provided in the two driving coaches, and the train is equipped with automatically operated collapsible folding steps, which are operated from the brake exhauster system.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

A LOCOMOTIVE TESTING PLANT.

SIR,—From time to time I have seen references to the possibility of having a locomotive testing plant built in England, which can be used by any railway or locomotive building company.* There is certainly the greatest need of such a plant.

As I have for many years made it a part of my business to test mill and pumping engines, as well as locomotives in service, and more recently on a test plant, I feel that I am in a position to state what a locomotive test plant should be.

No locomotive testing plant has been built that gives more than an approximate idea of the steam or coal consumption of a locomotive. If the method used is compared with that prescribed by the American Society of Mechanical Engineers for stationary and pumping engines, and of boilers, it is crude in the extreme. It is easy to obtain the indicated horse-power correctly, but this is of little use if nothing else is correct. The results of two tests of the same locomotive, operating under the same conditions in all respects, are likely to differ widely, and by plotting a number of results, the points are frequently too far apart to be of value, and no point is likely to be correct. In fact, nobody knows what is correct. It is assumed that a mean line of such a diagram is correct, but a correct result cannot be obtained from a collection of incorrect ones.

The reasons for inaccuracy are that there are several uses of steam beside that by the main cylinders. Nowadays, on locomotives, steam is used by the feed pumps, stoker engines and stoker jets—if there are such—and overflow of the heater, but, worst of all, is the steam blown off by the safety valves. I will not here describe the method of attempting to obtain the amounts of these wastes, but all but that of the safety valves are perhaps correct enough to prevent serious final errors.

Safety valves may blow for a long time, one or two may blow, and they may simmer. The safety valves have capacity enough to relieve the boiler of as much steam as the cylinders use. It is impossible to estimate properly this waste, although efforts are made to do so.

Another trouble is to make tests sufficiently long. They may be half an hour or an hour in length, but such short tests cannot satisfy anybody, either for steam or coal used. The coal level in the fire-box is estimated by a skilled fireman, but he cannot have skill enough to estimate the level of a fire and the amount of ash which it contains, with sufficient accuracy to render the result in an hour of much value. He is supposed to have as much coal on the grate at the end of a test as at the beginning, but that is impossible. The test therefore should be long enough to render this error harmless. If a testing plant should be built that can be operated continuously for as many hours as desirable, one test would be more valuable than half-a-dozen half hour or one hour tests. The limit now depends upon the integrity of the brakes. At present nobody can tell whether an error is plus or minus.

Now the way to overcome these difficulties is to have the steam consumption tests made with steam from stationary water-tube boilers and passing through a separately fired superheater. It would not be difficult to connect the cylinders to the steam pipe from stationary boilers, and it would be advantageous to use several amounts of superheat, which could readily be done. Moreover, the boilers could be built for any pressure that is likely to be used in the future.

In order to ascertain exactly how much steam the locomotive uses, and to eliminate all errors in water quantities, the exhaust should pass through a surface condenser, the discharge of which could be accurately weighed. The back pressure could be made anything from zero, or near that, to a maximum of any amount. If a locomotive should be tested on such a plant, nobody could be dissatisfied with the result, and two tests under each condition would be enough.

As for coal determinations and certain other purposes, it would be necessary to use the locomotive's own boiler, and if the brakes which absorb the power were properly designed and sufficiently rugged, the tests could be run six hours or more, and the coal error would be so slight that it could be ignored. Two tests under each condition would be enough.

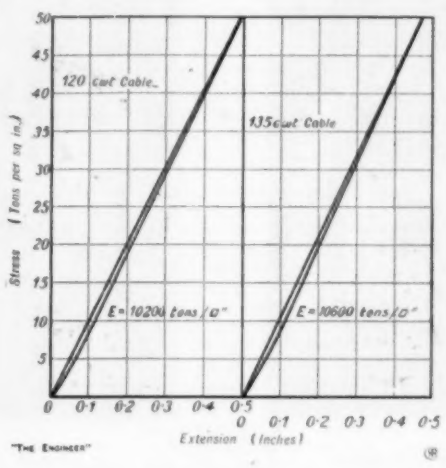
F. W. DEAN.

261, Franklin-street, Boston, Massachusetts.
April 24th.

* THE ENGINEER, March 23rd, 1928.

THE USE OF WIRE ROPE IN STRUCTURAL FRAMEWORKS.

SIR,—The problems referred to by your correspondent "Hexagon" have long been familiar to aircraft designers. By using straining cord of a particular lay, together with suitable end connections, an effective value of Young's modulus of 10,000 tons per in.² has been obtained. The enclosed figures illustrating two of many tests on 8ft. specimens complete with ends are evidence also of the high



elastic limit and low hysteresis with this type of tension member. Prolonged loading tests have confirmed the absence of creep.

The observation made by your correspondent on the difficulty of obtaining "effective, certain and reliable co-operation" between materials having varying values of E, appears to arise from confused ideas of structural theory, as does also his earlier suggestion that "there should not be even slight distortion," which is manifestly an impossibility in materials of finite physical properties.

In the case of R.101, in addition to strength tests on practically the whole of the structural members and joints under varying conditions of loading, observations were also made of the elasticity of these members. The results of these observations furnish the necessary information for the strain energy calculations, the accuracy of which has been confirmed by the experiments on a section of the ship, which were described by Colonel Richmond in his paper.

One further point, the observation in the penultimate paragraph of your correspondent's letter would appear to suggest that a structure in which shear forces are distributed in an indeterminate manner by gusset plates and rigid joints is preferable to a braced pin-jointed structure. This point of view will, I am sure, not commend itself to aeronautical engineers or to any structural engineers who desire to determine by design methods, with a reasonable degree of accuracy, the distribution of the stresses in a structure.

For BOULTON AND PAUL, LTD.,
JOHN D. NORTH,
Norwich, May 7th. Chief Engineer.

A WATERWORKS QUERY.

SIR,—Owing to a controversy between some friends and myself, I wish to ask through the medium of your columns, if any engineer, with experience covering the subject, will favour me with his opinion on the following point.

When pumping from a 14in. bore tube, which is down to soft grey sandstone 200ft. below the surface, a varying quantity of sand is lifted with the water, say, from nil to ·025 per cent. volume. The pumping level of water in the bore may be taken as 60ft. below surface, and the mean velocity of water in the bore tube as ·75ft. per second. More or less starting and stopping of the pumps unquestionably affects the quantity of sand delivered. The bore tube has been pumped from for some three years.

Now, suppose a well of large diameter, say, 12ft., be made to, say, 125ft. deep, near the bore tube, and it be connected to the bore by an adit at the bottom of the well, and the water then pumped from the well instead of the bore tube. Would there then be any accumulation of sand in the well?

The type of pump and the cost are not material to the query.

I base my opinion on previous experience under somewhat like conditions. The water in the well will act as a buffer against sudden changes in velocity in the bore tube in proportion to the area of the well, and it is the comparative sudden changes in velocity which causes the sand to be disturbed. With a well of the size given, I believe the velocity in the bore could be increased trebly and the pumping level taken down to, say, 110ft. or more without sand being lifted.

Thanking you for the courtesy of insertion.

May 7th. LEWRETAW.

South African Engineering Notes.

Union's Locomotive Policy.

THERE has been much speculation over the announcement just made that the Railway Administration is likely to place orders for new locomotives to the extent of approximately £1,000,000 in the near future. It is understood, on good authority, that the Railway Administration has now in commission approximately 1800 locomotives. Many of these are of the old types, and have been in service for nearly twenty years, and the average life of a railway locomotive is a little less than twenty years. In order to keep pace with depreciation, the railway authorities have therefore to resort to a 5 per cent. replacement programme. This means that in order merely to maintain the present stock of railway locomotives, a purchasing programme of 90 new engines each year is necessary, and, in addition, a further number to meet the expansion of the railway service, so that probably over 100 new locomotives are needed each year. When the orders for "Garratt" and "Mountain" engines are completed, the Union's requirements in bigger engines will have been met for some time to come. After that, big orders for electric freight locomotives for the Natal line and for the Cape Suburban line may be expected. Much the larger portion of this latter demand will be for the Natal line, on which the Railway Administration is anxious to put on big units, one of which will do the work of three of the units at present used. The specification sent out called for a locomotive with a tractive power of 66,000 lb. at 20 miles an hour, and 21,000 lb. at 36 miles an hour, and to attain a speed of 45 miles per hour, but the Administration's ideas appear to be expanding rapidly, and a tractive power of something like 75,000 lb. and ability to draw trains running to 2500 tons seems the present ambition.

There is no doubt that with all the accidents which have occurred, and which continue to occur, misgiving has been created as to whether the permanent way is up to the stresses which the enormous locomotives now being put in service impose upon it. As bearing upon this point there is the fact that a large quantity of 85 lb. rails have been ordered from Germany. They are wanted for electrified sections of the Union railways in Natal, where rails have been splitting. The official explanation is that the splitting was chiefly due to the facts that:—(*a*) The 80 lb. rails used were somewhat light for heavy traffic moving at high speed over electrified sections of the line; and that (*b*) 80 lb. rails have split because the bogies of electric locomotives had not been adjusted to meet the curves on the permanent way. The above statements are hardly completely reassuring, and when the contemplated monster locomotives are put on there are many who, before they feel comfortable travelling, will want the assurance of some expert of world-wide reputation that the track is strong enough for the stresses.

Mining by Fire.

The experiments at the New Modderfontein gold mine, on the Rand, with devices for mining by flame have proved so successful that the technicians of the Central Mining-Rand Mines Groups mines have decided on the extension of work of this nature, and have ordered further blow-lamp appliances. The oxy-acetylene lamp employed produces a flame which develops a temperature of about 1200 deg. Cent. at the face. The flame is 6ft. long and 6in. wide, with a thickness of 1in. at the point of impact with the rock. As a result of the work carried on at the New Modder Mine, it seems probable that mining by fire will be widely adopted on the Rand in work on upper levels. The increase in temperature induced by the device may, it seems, render it impracticable to employ this method in deep workings, but it has been demonstrated that the devices used are capable of mining ore at substantially less cost than in the case of more ordinary methods for which explosives have to be used, and it has been ascertained, too, that by the employment of these devices in upper levels mining costs of the Rand are likely to be considerably reduced. It is just these upper levels which give the greatest difficulty in mining by ordinary means. Where remnants of ore reserves and isolated blocks have to be removed, it is generally desirable to set up as little vibration as possible in the removing of the ground, and the flame methods of mining in such areas will, it is anticipated, be especially satisfactory.

Salt River Power Station.

The new power station erected by the Electricity Supply Commission to supply power for the running of the passenger trains on the suburban lines between Cape Town and Simonstown has been put into commission. Situated a couple of miles from Cape Town this 30,000 kW station is linked up with the municipal power station of about the same capacity, so that at any time the one can assist the other. The electrification of the suburban lines will not be completed until June or July, by which time the two big 6ft. pipe lines which are being run out to sea for a distance of 1200ft. will have been completed, so that salt circulation water can be supplied to the condensers at the power station.

Antimony Ore Treatment.

A considerable addition to the mining industry of the Union is foreshadowed as the result of the successful experiments said to have been made with a process for the treatment of the antimony ore of the Murchison range, Northern Transvaal. As the result of the experiments, it is thought probable that one of the many dormant mines in that district will be acquired and worked by the owners of the process. The ore in some of these ores is said to contain 8 dwts. gold and 12½ per cent. of metallic antimony. If the results of the experiments are confirmed handsome profits should be won from the Murchison range ore, seeing that the market value of antimony is £45 per ton. There are also larger quantities of antimony ore elsewhere in the Union, and also in Rhodesia, so that if the process is proved to be all that is claimed for it, there will certainly be an extension of mining activities to districts at present neglected.

Railway Matters.

THE Johannesburg–Cape Town mail was derailed in the Hex River Pass on Friday, April 27th, and at least eight persons killed. The accident occurred near the same spot as the troop train disaster in September, 1914, when nine were killed.

THE vacancy created by the removal of Mr. W. E. Thornhill, from Bangor to Crewe as district engineer, London, Midland and Scottish Railway, has been filled by the removal of Mr. J. Briggs, the Derby (Southern) district engineer, to Bangor.

ACCORDING to a cable message in *The Times* for May 4th, yet another change is to be made in the administration of the New Zealand Railways. They have always been State owned and administered by railway commissioners through a general manager. In 1924 a Railway Board was appointed, whose chairman replaced the general manager. That position, the cable says, is to be revived and the Board abolished.

APPOINTMENTS have now officially been made in succession to Mr. J. T. Roberts, who retired in May last from the position of signal superintendent of the western section of the London, Midland and Scottish Railway, and to Mr. W. C. Acfield, who retired in August from the corresponding position on the Midland section. Mr. Acfield's assistant, Mr. H. E. Morgan, goes to Crewe to succeed Mr. Roberts, and Mr. Roberts' assistant, Mr. A. Oldham, is removed to Derby as successor to Mr. Acfield.

THE colour scheme of the London, Midland and Scottish locomotives has been revised, and the "Royal Scot," "Claughton," "Prince of Wales," 4–6–0 and the 4–4–0 standard compound classes are to be painted red; all other passenger engines will be black, lined with red; all goods engines to be black. Tender engines are to have their numbers on the sides of the cab panels and L.M.S. lettered on the tender; tank engines are to have their numbers on the sides of the bunkers and L.M.S. on the side tanks.

THE report, for the year ended March, 1927, of the Indian Railway Board remarks that re-investigation into the advisability of electrification of suburban lines in the vicinity of Calcutta and Madras was completed during the year. The results of the investigations were under consideration at the time the report was prepared. Proposals for the electrification of the Trichinopoly-Madura and other sections of the South Indian Railway had also been under consideration by the Railway Board, in view of the possibility of the supply of cheap power from hydro-electric sources.

WE have to record with regret the death on May 2nd of Mr. William Pickersgill, who retired from the position of chief mechanical engineer to the Caledonian Railway soon after that company became merged with the London, Midland and Scottish Railway. He received his training at Stratford, but it was on the Great North of Scotland that he established his reputation as an engineer and administrator and, in particular, as an educational force. Whilst all were delighted at his removal in 1914 to the Caledonian to succeed Mr. McIntosh, his loss was greatly felt at Inverurie, where, under Mr. Pickersgill's supervision the Great North of Scotland established its locomotive carriage and wagon works in place of those at Kittybrewster.

IN a statement to a Parliamentary Committee at Ottawa on April 24th Sir Henry Thornton, President of the Canadian National Railways, said that deficits from operations on the branch lines had been converted into surpluses by the substitution of Diesel-electric cars for steam trains. He believed, he said, that the development of the Diesel electric unit offered a solution of the problems which involved the provision of service on branch lines which could not profitably be operated by a steam train. Where the electric cars had been put on loss had been turned to profit. The gross revenue of that service last year was 450,000 dollars, and the expenditure 238,000 dollars, so that there was a profit of 211,500 dollars. The company had in contemplation a larger unit, based upon the results of the smaller units, but its success had yet to be tested by experiments.

THE inquiry into the collision that occurred at Euston on April 30th was opened on Monday, May 7th, by Lieut.-Colonel Mount. The accident arose out of the vehicles that were to form the 2.35 p.m. express to Liverpool being turned into the same road as that in which the coaches were standing, without their engine, that were to form the 2.20 to Birmingham. About half a dozen passengers were hurt, but it was necessary to detain only one at the hospital. The evidence of the driver of the engine which was taking in the Liverpool train was that the signal was lowered for him to enter No. 12 platform, so he proceeded. Owing to the pier of a bridge, he could not see the line before him, and only saw the obstruction one engine's length away. From the evidence subsequently given by the two signalmen concerned, it would seem that one man assumed that the other had made certain movements, which, actually, had not been made.

WHAT may possibly be one of the objections to the transfer of Charing Cross Station to the south side of the Thames was pointed out in a letter that appeared in *The Times* of May 4th. The writer said there that the present Charing Cross Station was situated at the very heart of the London Underground system, whose lines, radiating in every direction, bring it in direct communication with all the other termini and all outlying districts. He proceeded to say that a new and larger Waterloo would cause extreme discomfort on the Tubes under the river. Our answer to both these objections is that the two Tube railways which serve Charing Cross also serve Waterloo; the only link that would be missing would be the transfer to the District Railway and that can just as conveniently—in fact, more conveniently—be made at Cannon-street. On the other hand, the *Manchester Guardian* of the same date, commenting on Mr. Bernard Shaw's letter in *The Times* of the previous day, spoke of our "using one of the finest sites in Europe for a station which nowadays is no more than a terminus for local passenger traffic into Kent and Sussex."

Notes and Memoranda.

THE new tug which has been ordered by the Durban, Natal, harbour authorities from Sir W. G. Armstrong, Whitworth and Co., is to have a length of 170ft., breadth of 34½ft., and depth of 17½ft., with twin screws driven by two sets of inverted three-cylinder, triple-expansion engines, with surface condensers, of 3000 I.H.P. at 110 r.p.m., giving a speed of 13 knots.

IN the House of Commons, Mr. Day recently asked the President of the Board of Trade whether the preliminary trials of the rotating loop direction-finding system, investigated by the Department of Scientific and Industrial Research, had proved satisfactory; whether he could now state if it had been decided by his Department, in conjunction with the Air Ministry and Trinity House, to establish an experimental station of this type; and, if so, where this station would be established? In reply, Mr. Herbert G. Williams said that as a result of the preliminary trials of the rotating loop system—a report on which, he understood, would be published shortly by the Department of Scientific and Industrial Research—it was proposed to erect an experimental station at Orfordness for air and marine navigation, which could be tried under service conditions. The arrangements were not yet completed, but he would let the hon. member know as soon as a definite decision was arrived at.

MANY attempts have been made to use carbon dioxide in fighting mine fires by introducing it behind seals. More recently, carbon dioxide snow has been proposed for fighting a fire directly. In some of the earlier attempts to employ carbon dioxide behind stoppings, as at the Engleville mine in Colorado, about twenty-five years ago, the carbon dioxide was made at the mouth of the mine by sulphuric acid applied to limestone in water in closed vats, and was blown through a pipe that extended through the fire stopping. At the Engleville mine the attempt failed because breaks in the strata over old workings extended to the surface, and the area could not be sealed tight. At other mine fires tanks of liquid carbon dioxide have been used. The only advantage from the use of carbon dioxide is that the pressure created by moving the gas into a fire area tends to keep external air from entering if the ground is so broken that the sealing cannot be made tight. When the seals are reasonably tight, the rapid absorption of oxygen by the coal makes the use of carbon dioxide unnecessary.

FOR broadcasting a running commentary on the Grand National horse race at Aintree, six microphones were utilised. Three of them were specially constructed, measuring only 2in. by 1¼in., and could be accommodated comfortably in the palm of the hand; but as the commentator required both hands free to use his field glasses, the microphones were clamped to an iron rail and spaced over a distance of about 2½ft., so that as the commentator turned his head to follow the horses, one or other was within 6in. of his mouth. These diminutive instruments are not as sensitive as the normal type, but the quality is declared to be as good as any that has hitherto been obtainable by wireless, and the use of "insensitive" microphones was intended to enable the crowd effects to be more carefully controlled, so that the speech would not be drowned by the incidental noises of the course. It must be remembered that the commentator spoke in the midst of a noisy and enthusiastic crowd. A separate microphone was used for preliminary announcements, and two others were placed in front of the stand to pick up crowd noises and to be in reserve if required.

IN a statement concerning the recent disastrous explosion in a factory near Nuremberg, where aluminium powder was made, the Reichsverband der Deutschen Aluminiumwaren Industrie of Berlin says: Powdered aluminium is extraordinarily light, and, if blown about in the air, particles can remain suspended a very long time. Such a suspension is as dangerous as a coal dust suspension in air, and is capable of ignition by a spark or any other form of local heat, whilst in the compact form the powder is perfectly safe and will only glow quietly on the application of local heat. So far as the disaster at Nuremberg is concerned, it seems certain that the usual precautions and safeguards were taken. Unfortunately, the exact cause of the explosion cannot be ascertained, owing to the death of those who were actually working with the material. It seems probable, however, that a spark was produced by the breaking of a machinery part. Assuming this to have been the case, it seems very advisable in the future to replace all iron and steel machinery parts working on aluminium dust by lighter metals, and particularly by aluminium itself, since by the breakage of this latter there is little possibility of a spark occurring.

A NEW 60,000-kW turbo-generator set which has been added to the plant of the Buffalo General Electric Company, N.Y., operates in conjunction with a three-phase auto-transformer rated at 66,667 kVA, 12,000 to 22,500 volts, 25 cycles. The "low-pressure" winding is solidly connected to the generator terminals and the high-pressure windings feed into the 22,000-volt transmission line through circuit breakers and disconnecting switches. In order to keep the short-circuit strains on the system within the limits for which the equipment on the system was originally designed, the auto-transformer is designed with a special double-winding arrangement. Each phase has two parallel windings permanently connected together at the neutral and 12,000-volt taps. One winding connects the line through 5 per cent. reactors, and the other through similar reactors and an oil circuit breaker. This "reactance breaker" is operated by instantaneous overload relays set to trip when the generator output exceeds 300 per cent. of its rated current. With both windings connected, the auto-transformer has an impedance of 3·8 per cent. on 66,667 kVA, but when the reactance breaker trips the impedance is changed to about 18 per cent. on the same capacity, and this large increase comes into circuit before any circuit breakers have tripped at the terminal station, with the exception of a bus-bar junction breaker which has ample rupturing capacity. When the "reactance breaker" opens, it leaves the generator synchronised with the load, and as soon as the initial disturbance has passed, the operator at the generating station re-closes the breaker.

Miscellanea.

THE ironstone mine at Great Ayton, Yorkshire, which has been closed since last summer, has been reopened by Messrs. Pease and Partners.

A NEW company has been formed in Pretoria for the manufacture of reinforced concrete pipes. Its title is the Viviani Ferro-Concrete Pipe Company.

TESTS made on the brown coal mined at Waikato, New Zealand, show that it can be briquetted commercially; 1 ton of the coal will yield 12 cwt. of semi-coke, containing 7¾ per cent. volatile matter, 10·8 gallons of tar oil by condensation—which is equal to a yield of 4·6 per cent. on the coal—1·69 gallons of light oil; the calorific value of the semi-coke is 7180 calories, or 12,924 B.Th.U.

THE new field house for the University of Minnesota in Minneapolis, which has just been completed, is, according to the *Engineering News-Record*, a structure 440ft. long and 236ft. wide. The main structural frame of fourteen three-hinged steel arch trusses, 100ft. high at the centre and spaced approximately 30ft. apart along the building, is enclosed in brickwork and covered with a steel plate roof insulated and waterproofed.

THE first meeting of the newly established Hydrographic Confederation of the Guadalquivir, which has been formed on the lines of similar organisations in other districts to deal with river matters, was held at Seville on May 2nd, the King of Spain presiding over a distinguished gathering. The Minister of Public Works, in a speech, pointed out the opportunities afforded by such bodies of exploiting the natural riches of the country. Works in the Guadalquivir valley would, he said, irrigate 1,500,000 acres and supply electricity on a large scale.

IN connection with the scheme to connect Korea and Japan by submarine telephone, the section from Fukuoka to Idzuhara, in Japan, was incorporated in the Budget of 1927, and the work will be caried out shortly. The section from Idzuhara to Fusan, in Korea, is included in the Budget for 1928. The cable will be purchased abroad, and immediately on its arrival the work will be put in hand, an item of 700,000 yen (about £70,000) being allotted for this purpose. It is expected that the line will be completed by October next.

ELECTRIC welding can, says *Vulcan*, be frequently employed with advantage in effecting boiler repairs, but it cannot be employed indiscriminately or without the exercise of judgment by experienced experts. In some cases we have met with the application of electric or autogenous welding has been worse than useless, as it has engendered a feeling of security that did not exist, by simply hiding defects. These, it should be remembered, are sometimes simply the expression of hidden stresses arising from bad design or maltreatment, and for efficient repair, call for something more than the hiding of a crack by fusion, which is all that an electric welding occasionally amounts to. The deeper seated cause of the trouble may remain untouched and sooner or later again make itself manifest.

THROUGH the breakage of a connecting-rod at the Albion Steel Works of the Briton Ferry Steel Company, Ltd., while the engine was running at full speed, a smash occurred which, according to the *Ironmonger*, it was considered, would render the plant idle for two months. The engine is a reversing type, 2500 horse-power, and the cylinder, bed-plate, valve casing and pistons were all broken. The stoppage was serious, as the local tin-plate works depended for their supplies of bars on this engine. Repairs were commenced within an hour of the accident, and, working right through at the highest possible pressure, the engineers, Taylor and Sons, Ltd., of Briton Ferry, were able to complete the repairs for the mill to be restarted in under three weeks from the date of the breakdown. The large cylinder was delivered and fixed within sixteen days. This, they state, constitutes a record, being under half the time of any similar previous job.

THE Government of the State of Santa Catharina has concluded a contract for the improvement of the port of Itajahy, the principal outlet of the thriving district in the valley of the Rio Itajahy. The work will include dredging an obstructive sand bar, cutting away the river banks for a distance of several thousand feet, the erection of a breakwater and various other improvements. Simultaneously, the dredging will be begun of the entrance to the port of Florianopolis, capital of the State of Santa Catharina. The cost of these enterprises, both to be completed within twelve months, is estimated at £48,000 and £72,000 respectively. A third contract has been awarded for improvements at Laguna, the principal southern port of the State of Santa Catharina, and the terminus of the Dona Theréza Christina Railway. The contract calls for the extension of the dock to a total length of 780 m., the construction of two additional breakwaters, and the dredging of the channel and the mouth of the lagoon. Important discoveries of coal are reported to have been made in the valley of the Rio Tubarao, and the Government of Santa Catharina intends to develop them.

THE New Brunswick Legislature has just passed a Bill giving consent to a project for the development of tidal power in Passamaquoddy Bay, an inlet from the Bay of Fundy. The project is one involving a large number of interests, and is international in character, as Passamaquoddy Bay is on the boundary line between the Province of New Brunswick and the State of Maine. In the Passamaquoddy Bay the rise and fall of the tide is within the range of 28ft., and the scheme proposed by Mr. Dexter P. Cooper, a New York engineer, contemplates the construction of dams and the linking up of various islands. It is estimated that the cost of the development is likely to be between 50 million and 75 million dollars, and that the electrical energy made available would ultimately reach 700,000 H.P. or 800,000 H.P., starting with an initial development of from 400,000 H.P. to 500,000 H.P. The construction of the works would occupy some forty-two months and employ between 3000 and 4000 workmen. The apportionment of power as between the Province of New Brunswick in Canada and the State of Maine in the United States will have to be decided by the International Joint Waterways Commission.

500 B.H.P. OIL-ELECTRIC TRAIN FOR THE L.M. AND S. RAILWAY

WILLIAM BEARDMORE AND CO., LTD., AND THE ENGLISH ELECTRIC COMPANY, LTD., ENGINEERS

(*For description see page* 514)

FIG. 4—GENERAL VIEW OF FOUR-COACH 500 B.H.P. OIL-ELECTRIC TRAIN

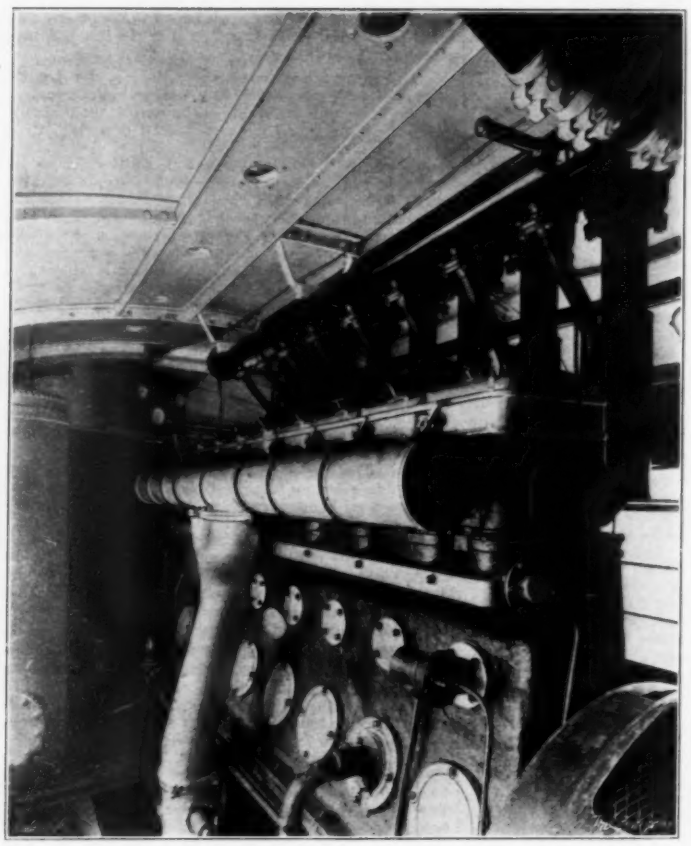


FIG. 5—FRONT VIEW OF ENGINE FROM GENERATOR END

FIG. 6—BACK VIEW OF ENGINE FROM GOVERNOR END

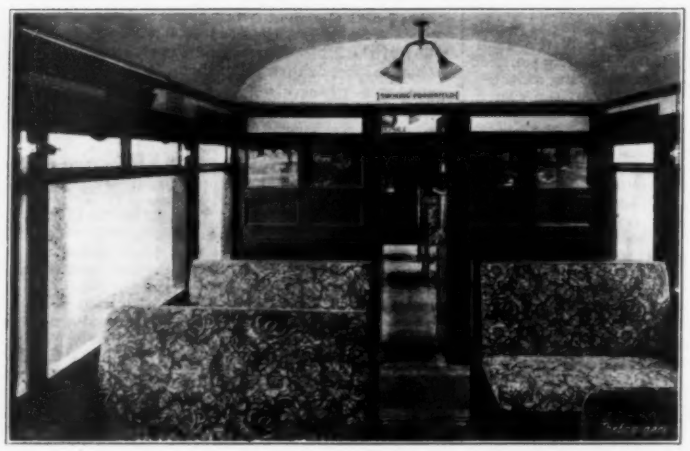


FIG. 7—FIRST-CLASS NON-SMOKER COACH

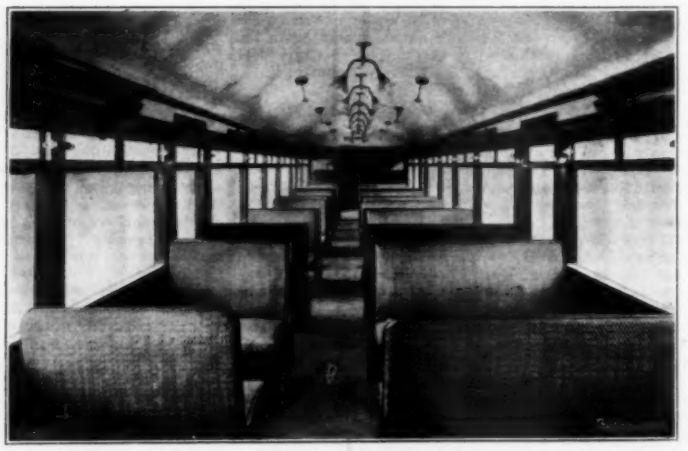


FIG. 8—THIRD-CLASS SMOKING COACH

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MAY 11, 1928.

Mr. Schwab on British Steel.

IT is, indeed, rarely that an after-dinner speech makes such an impression in technical circles as that which Mr. Charles Schwab delivered after the banquet of the Iron and Steel Institute last week. Mr. Schwab owes not a little of his success as an orator to a personality which draws men to him, but at the same time he speaks of the iron and steel industry from an experience which extends backwards almost to the time when the position of Great Britain in the iron and steel trade of the world was still unchallenged. He has not only seen the rise of that industry in his own country, but has contributed to it in great measure by his organisation of the Bethlehem Steel Works and by the influence which he is able to exert in the steel markets of America. Hence he makes a double call upon the attention of those who are fortunate to hear him speak, for on the one hand he attracts by his irresistible sympathy and friendliness and on the other by a knowledge in which few are his equals and none his superiors. In his speech he showed no signs of rejoicing, as a less generous competitor might do, over the difficulties in which the iron and steel industries of this country are involved, and we take it that the advice which he offered to Great Britain was the best that he knows how to give. It may be summarised in a very few sentences. First, pay greater attention to your home demand; secondly, protect your industry from foreign invasion by a substantial tariff; and finally, organise the great diversity of iron and steel makers into a few large groups. Making all due allowances for the influence of the speaker's personality and the sometimes irresponsible enthusiasm which pervades an after-dinner audience, it is yet remarkable that these three propositions were received with acclamation by a company consisting very largely of iron and steel makers who, in less exhilarated moments, are known to exhibit violent antipathies to at least one of the recommendations which Mr. Schwab made.

The present generation has grown up in the doctrine that Great Britain lives by her overseas trade. It has been taught that the possible consumption of commodities in the British Isles could never produce a sufficient demand to give adequate occupation to the large population. That is a fact that can hardly be doubted, but it is less true of the iron and steel industry than of most others. It is only necessary to recall that a large amount of iron and steel is imported, generally for conversion into other forms, to recognise that there still exists in the home demand vast potentialities. Mr. Schwab would have us believe that the United Kingdom, we presume, under proper stimulation, could consume all the products that our works, operating at their maximum capacity, could supply. He may be right; on the other hand, he may be arguing from the premises presented by the United States, which, we need hardly remind him, are very different from those of the United Kingdom. But to an outside observer it must appear an astounding fact that whilst many of our own iron and steel works are standing idle we are purchasing material from foreign countries; and an even more astounding fact that if we did not do so we should be unable to compete in many manufactured industries, notably shipbuilding, with our foreign rivals. That is an economic anomaly which it is easy to explain, but difficult to comprehend. Mr. Schwab would have us sweep it away by putting up a tariff against foreign iron and steel. If that had been as easy as it looks it would have been done long ago; and as long as the welfare of our industries, not alone of semi-manufactured, but of finished products, depends upon overseas markets the difficulties must remain. Could we but maintain sufficient employment in the satisfaction of the home supply, could we but be content to sell no more than our surplus to foreign lands, as Mr. Schwab suggested we might do in iron and steel, then the incidence of a tariff, whatever effect it might have on prices, would be as tolerable in this country as in the United States. But as long as we place dependence on the sales which we are able to effect abroad in competition with other nations, the necessity of purchasing cheap steel for certain industries will remain and the opposition to a prohibitive tariff will not abate. We have no doubt whatever that Mr. Schwab saw our problem from this point of view, and that it was for that reason that he placed the need of a home market side by side with that of a tariff. His third article of advice springs from the same source; he holds that here, as in America, the costs of production could be reduced by wise amalgamations. On that point there will be less criticism amongst British iron and steel masters, for "rationalisation" is in the air and nowhere more so than amongst those industries of which Mr. Schwab was speaking.

It is a coincidence that Sir Arthur Balfour's Committee should have issued its "Survey of Metal Industries" at the very moment when steel masters are discussing the advice which we have outlined above. The first part of this Report, which is obtainable from all the Government publishers, is devoted to the iron and steel industries. Mr. Schwab expressed the hope and the belief that those industries would, before long, emerge from their troubles. The Report sustains that view. We learn that the iron and steel industry of the world has grown at less than the anticipated rate. The output of pig iron in 1927 was 85 million tons instead of 140 million tons, and of steel 100 instead of 150 million tons. It was not to be expected that the percentage rates of increase would continue indefinitely, but the Committee holds that the limit of annual demand is not yet in sight. It believes that the check is temporary and that recovery will follow as the special influences which have caused the retardation in demand are dissolved. It believes, too, that Great Britain will participate in that improvement by reason of the *quality* of its products, and it doubts if it would be advantageous for British manufacturers to establish very large plants for the production of common qualities of steel products. In these opinions of a Committee which has investigated the national problem with extraordinary care we may justly find good grounds for hopefulness. As Mr. Schwab very generously said, every great advance in the technique of iron and steel manufacture has had its origin in this country. There is no reason to think that our knowledge or our enterprise is less than it was, and though we may perhaps never hope to compete with the United States, with their vast unsatisfied home market, in mass production we may yet regain and retain a sufficient industry for our needs in the production of irons and steels of the highest quality.

Projected Atlantic Liners.

FOR several months past the air has been full of rumours, not to say positive reports, about the projected construction of ocean liners which are to surpass all existing vessels in size, speed, and

luxury. As we recorded in a "Journal" note last week, both the White Star Line and the Cunard Company are credited with having in view the building of such vessels, but so far neither company has seen fit to confirm or deny these reports. There are, no doubt, sound business reasons for preserving reticence in this matter. On no other ocean route is competition so keen as that of the Western Ocean, where a number of great lines are engaged in a more or less friendly rivalry. In these circumstances there is a natural reluctance on the part of any one company to divulge its shipbuilding plans in advance, particularly where they relate to vessels of a novel type. There are, however, certain indications which seem to foreshadow early developments in this connection. It is, for instance, no secret that the New York harbour authorities have been approached by more than one shipowning concern on this side with regard to the provision of berthing accommodation for liners superior in tonnage and length to any now afloat. The construction of several 1000ft. piers is now being considered by the New York Dock Commissioner, and Mr. P. A. S. Franklin, the President of the International Mercantile Marine, is quoted by the American Press as having stated that "the new White Star liner will be larger than the Majestic," the latter vessel being of 56,551 tons gross, with an overall length of 956ft. As for the Cunard Company's plans, the only light shed upon them comes from Sir T. Ashley Sparks, the resident director of the Line in the United States, who was reported some months ago in a New York paper as having said that "the next big ship we build will take the shine out of everything afloat," an intriguing if somewhat vague statement.

Public interest in the future of Transatlantic shipping has been aroused, not merely by the foregoing reports, but by the definite news that our possession of the "blue riband" of the Western Ocean, which we have held for more than twenty years, is about to be challenged by Germany. We regained that trophy in 1907, when the Mauretania and Lusitania, then newly completed, easily outstripped the fastest Norddeutscher Lloyd liners—Kaiser Wilhelm II. and Kronprinz Wilhelm, 23·5 and 23·4 knots respectively—which had previously held first place for speed. But for the intervention of the war there is little doubt that the Germans would soon have retorted with something faster than the Mauretania, but as events fell out this splendid ship has maintained an unbroken supremacy for no less than twenty-one years. Unfortunately, it seems inevitable that her long reign will come to an end next year, when the two Norddeutscher liners, Bremen and Europa, now under construction, pass into service. According to reliable information they are to be ships of 46,000 tons gross, equipped with single-reduction geared turbines and water-tube boilers delivering steam at the high pressure of 350 lb. The designed output is 96,000 S.H.P., and a sea speed of 26½ knots is confidently anticipated. This, it is true, is only a fraction above the best performance of the Mauretania, which crossed from New York to Cherbourg in August, 1924, at an average of 26¼ knots. But a veteran in her third decade of continuous service cannot hope to hold her own against newly built ships of relatively higher engine power, and we must therefore be prepared to see the Mauretania's record passage beaten when the two German vessels have got into their stride. This, however, is a friendly rivalry which excites no ill-feeling, but only a keen interest, both public and professional. Occasionally an element of real humour creeps in, as in the early days of the competition, when the Norddeutscher ship Kaiser Wilhelm der Grosse, which had been built avowedly for the purpose of racing the Campania and Lucania, arrived at Spithead on her maiden voyage with a huge blackboard slung across her counter bearing the legend "Made in Germany." At the same time, having every confidence in the enterprise of British shipowners, we do not believe that they will remain idle while the "blue riband" passes again into German hands. If it be true that the projected White Star liner is to have oil engines, her speed is not likely to be equal to that of the fastest turbine steamers already afloat, in which case she will be remarkable only for increased tonnage and passenger accommodation. In the case of the Cunard Line, however, with its tradition of high speed, something more striking in speed may reasonably be looked for. Pending further information we shall not comment upon the story that the next Cunarder will be a 28-knot ship, beyond observing that the design and construction of such a vessel would present no very formidable problem to our leading shipyards. We have a lively recollection of the lugubrious forecasts that were heard when the design of the Mauretania and her sister was first announced. In some quarters the installation of machinery of 75,000 S.H.P., almost double the power of any previous ship, was regarded as being revolutionary, if not suicidal. It was freely predicted, first, that the designed power would never be attained, and as those were the days of coal firing this particular criticism did not seem inapt; secondly, that machinery so driven would soon shake itself to pieces; thirdly, that no hull built would ever stand the strain; fourthly, that the vibration would be so great as to render life unendurable to all on board. The fact that these predictions were one and all falsified must have been extremely gratifying both to the designers and owners of the ships. Yet it remains true that, with the single exception of the "Great Eastern," no bolder step was ever taken in the domain of shipbuilding and engineering. We might have said "experiment," but that would be a misleading term. There was nothing experimental in the perfectly moulded lines of the Mauretania or in the planning and construction of her machinery. The design in all respects was based upon meticulous calculation by the most experienced shipbuilders and engineers in the world, but it is only just to add that this signal triumph from the technical point of view was made possible in the first instance by the pioneering spirit of the shipowners.

While it is certain that a considerable section of the travelling public prefers fast liners, and is willing to pay for the luxury of high speed, it has yet to be demonstrated that the laws of demand and supply are applicable to the scheme which a group of American business men have been promoting of late. They propose to build six ships which would be capable of crossing the Atlantic in four days, "from dock to dock," thus saving a full twenty-four hours on the fastest passage which has been accomplished to date. The detailed plans of these vessels have not yet been made public, but Mr. Laurence Wilder, who appears as the chief sponsor of the scheme, has revealed certain particulars. Mr. Wilder, by the way, represents the Transoceanic Corporation, which has influential backing in the American Brown-Boveri Electric Corporation and the New York Shipbuilding Company, of Camden, N.J. The ships, he tells us, will be "more than 900ft. long and 90ft. beam, with a displacement of at least 35,000 tons, with accommodation for 800 passengers in greater comfort than exists on any Transatlantic liner of any nationality to-day, and with ample space for mail and 1000 tons of express cargo." With these six vessels it would be possible to maintain sailings three times a week from each side of the Atlantic. They would have a continuous sea speed of 33 knots and a maximum of 35 knots. A flight deck would be fitted to enable aeroplanes to leave the ship with passengers who were in a special hurry to reach their destinations. Each vessel is expected to cost £3,200,000. Mr. Wilder has estimated that each year about 300,000 first-class and cabin passengers, mainly American, cross the North Atlantic, and he is satisfied that his projected fleet could carry them all. With no desire to cast cold water on a project which is almost romantic in itself and extremely interesting from a technical point of view, we must confess that we were sceptical from the first, and are therefore not in the least surprised that the United States Shipping Board has made an adverse report on the whole scheme. That body had been approached in the hope that it would exercise its powers to grant a loan covering two-thirds of the building costs. Since it has returned an unfavourable verdict, the money, apparently, will not be forthcoming, so that the plan must be dropped unless the promoters have sufficient faith in their idea to put up the capital themselves. There is one very obvious objection which doubtless carried due weight with the Shipping Board experts. Granting it to be technically feasible to build a ship which could not only maintain a sea speed of 33 knots, but maintain it year in year out without respite—and that is a large assumption; granting, further, that such a vessel would be as safe, seaworthy, and comfortable as the average liner of moderate speed—an infinitely larger assumption, it follows that the running costs would be, to put it mildly, appreciably higher than those of the largest and fastest liner now in service. If that be so, the fares would have to be raised accordingly. Once that essential factor is introduced the whole case for the new fleet falls to the ground, or so it seems to us. Nothing is more certain than that any substantial increase in current Transatlantic passenger rates would at once bring about a marked decline in the volume of traffic. If it were otherwise we may be sure that our own shipping companies would not evince so much hesitation in ordering new ships of unprecedented speed. Finally, it would be interesting to know whether Mr. Wilder or any of his associates has ever travelled in a ship that was doing over 30 knots in a sea not quite smooth. In the light of our own experience we take leave to doubt it. If we are wrong we can only marvel at their optimism in supposing that the average ocean voyager, of either sex, would endure more than once a 33-knot crossing of the North Atlantic in the weather conditions normally prevailing in those latitudes.

Literature.

The Design and Construction of Dams. By EDWARD WEGMANN, M. Am. Soc. C.E. With a mathematical discussion and descriptions of "Multiple Arch Dams," by F. A. NOETZLI, D.Sc., M. Am. Soc. C.E. Eighth edition. 1927. London: Chapman and Hall, Ltd. Price 84s. 6d.

THE first edition, 1888, of this work related only to masonry dams. In the fourth edition, 1900, earthen, rock-fill, timber and steel dams were included, as well as the prinicpal types of movable dams. In subsequent editions there were added chapters on cofferdams, overflow weirs, crest gates, and syphon spillways. The present edition has been brought up to date by the author, while Dr. Noetzli, whom he regards as one of the best authorities on the subject, has provided useful matter relating to multiple arch dams. As nearly as might have been expected, under these conditions, and in view of the well-known character of earlier editions, the book fulfils the promise of the title. So large a field is seldom, if ever, fairly covered in a single treatise; but although Wegmann's work remains, to a dominating extent, a treatise on masonry dams, that predominance is partly inherent in the subject itself. All earthen and rock-fill dams may be considered as belonging to one main type, in the sense that there are some six main types of masonry dams, the forms of which may, further, depend upon the conditions at the sites more than do those of earthen dams. Wegmann's method of imparting information, depending, as it so largely does, upon the accumulative effect of descriptions and discussions of specific examples, seems to need more space than he has accorded to some other kinds of dams. Dams of timber and of steel may, in view of their relatively small importance, be considered as adequately discussed in the space allotted to them.

Whether dams made by the hydraulic process, and rock-fill dams, need more than some fifteen pages of text apiece for sufficient explanation of their nature and forms is a question that may be left to American critics. British engineers may, however, find that the twenty-seven pages of text and small figures allotted to earthen dams is, though extended by plates, insufficient for adequate presentment and discussion of the earthen dam and its problems. The author carefully considers methods and materials, but does so too briefly, and without reference to some recent opinions and experience of considerable importance. Some of his conclusions are, in the British view, not wholly acceptable. On page 225 he writes: "Masonry core-walls are doubtless the best means of insuring water-tightness in an earthen dam, and should generally be adopted when the means are, in the British will permit their use." This is a somewhat offhand treatment of the question, neither the puddle core nor the core wall being adequately discussed in the two pages allotted to them. The general study of the earthen dam, up to the stage at which the outlet receives consideration, occupies only seven pages, another page and a half being devoted to "construction." Some further information may be gained from the descriptions of works, but the reader is by no means fully informed on the subject.

Dr. Noetzli has furnished much useful information relating to multiple arch dams in the United States, with excellent illustrations. He also describes the Anyox dam, Canada; two French examples; the Scoltenna, Tirso, and five other Italian dams; two in Sweden, one in Germany, and the Great Lake dam in Tasmania. His general study of the multiple arch dam is thorough, but on a somewhat narrow basis. He presents Cain's method of calculating arch thicknesses, and discusses temperature stresses, explains how the dimensions of a normal buttress are calculated, and furnishes a few short notes on details of design. Though information relating to single arches may be gleaned from descriptions of works the calculations needed for such dams are, in so far as general directions are involved, confined to a statement that the method of computation used for multiple arch dams may be applied to single arches. The Stevenson Creek experimental dam is described and the results of the observations noted, but nowhere in the book is there a discussion of the method of computing separately the stresses in arch elements and in wall elements by the method of identical strains.

In the case of a dam intended to resist water loads

as an arch of no more than the required thicknesses, the other resistances may be neglected, as providing small additional factor of safety; but there are arched forms for which deflections otherwise considered must, with their corresponding stresses, be taken into account.

As regards buttresses, Dr. Noetzli, in marked and welcomed contrast with the attitude of most other engineers, sees merit in a form of buttress which, being under direct thrust, offers the advantage of "relatively clearly defined statical conditions." It is remarkable, however, that although Professor Luiggi's reports, in which Ryves' thrust buttress masonry dam design of 1910 is recommended, are mentioned in the bibliography, it is not to that design that he applies the phrase quoted, but to Rossin's development of the old timber weir form, in which the buttresses are replaced by frames. Thus, the relatively clearly defined static conditions are noted, but the design providing almost absolutely defined static conditions is ignored, though described ten years earlier than Rossin's proposed form.

The "additional dams" portion of the work is of considerable dimensions, and of no little merit. In the list of contents there are fifty-six entries, most of which relate to American dams or to groups of such. It is sufficient to note, of them, that the more important or typically interesting are well described, with very good illustrations, and include such as the Standley Lake earthen dam, the Calaveras hydraulically filled dam, and movable dams on the New York State Barge Canal.

Relating to dams in other countries, there are descriptions of the Saint Andrew's Rapids Movable Dam, Canada; Gatun Dam, indexed by a mistake as in Maine; a study of the curved dams of New South Wales, with a table of data for thirteen of them; and a discussion of the Cataract Dam; a description of the raising of the Assuan Dam; descriptions of the Bandana, Brasiano and Corfino dams, Italy; the San Anton and Camaras Dam, Spain. There are also six pages of short descriptions or notes of dimensions of other European dams, including those at Waggital, Eguzon, Grande Rhue and Schwartzenbach, and the Derwent and Howden dams.

The retention of the plates as furnished in earlier editions is a feature of the book that must not be overlooked, the series being of considerable importance. Of comparatively recent dams, now illustrated in this useful manner, there are but a few, such as Belle Fourche, Pathfinder, Rooseveldt, Olive Bridge, Gatun and Kensico dams. There are also plates of the Stoney roller gates for Beznau Dam, and of the cross sections of the New South Wales curved dams. For illustrations of more recent works the reader must turn to the figures and page illustrations, to be found with the textual descriptions.

Considering that in its forty years of useful life this work has grown until the 106 pages, 59 plates and 16 figures in the text have become 740 pages of text, 191 plates and 291 figures, it is remarkable that it can fairly take its place as a sumptuous modern treatise on masonry dams, in respect of which not a page unworthy of the present edition can be found. As a treatise on the design and construction of dams in general, it has the limitations of scope and method already indicated. Further, as it is necessary to point out for the benefit of students and young engineers, although the book should be carefully studied as a good treatise on masonry and timber dams and as affording useful information respecting other dams, its scope is limited in another sense. It portrays the science and art of dam building and furnishes the experienced engineer with many examples of their application; but, in respect more especially of the choosing and comparing of sites, of types more or less suitable for given sites, of the precise forms and dimensions and of materials, as well as with regard to problems to be solved partly at least on first principles and by defined criteria, the book has to a small extent only the character of a reasoned treatise. It is a work of very great merit as showing how dams are built and what are the salient features of their design, but of much less merit as providing instruction as to how dams should be designed and built, or as indicating the significance of features of designs.

The Manufacture of Artificial Silk. By E. WHEELER, M.B.E., A.C.G.I., A.I.C., with a foreword by Sir WILLIAM J. POPE, K.B.E., D.Sc., LL.D., F.R.S. London: Chapman and Hall, Ltd. 1928. Price 12s. 6d. net.

THIS is the first of a series of Monographs on Applied Chemistry to be issued under the editorship of Dr. E. Howard Tripp, who contributes an editorial preface.

In his opening words the author disclaims any idea that his monograph is exhaustive, and, as a subtitle indicates, it has especial reference to viscose. It is rather a matter for regret that Mr. Wheeler did not boldly adopt the word "Rayon" to describe his subject instead of persisting in the use of the misleading term "artificial silk," which becomes corrupted by the unscrupulous retailer into "art silk."

In the introductory and historical chapter it is pointed out how greatly the production of viscose has increased. The figures given are by no means the latest available, but the comparison is interesting as may be seen from the following quotation, to which we have added the figures for 1926:—

	1909.	1924.	1926.
World production in tons	7,400	62,000	1,509,000
	Percentage of world production.		
Nitro-cellulose	48	7·8	4
Cuprammonium	36	1·4	6
Viscose	16	88·0	84
Cellulose acetate	—	2·8	6

From the technical standpoint the first three differ from the fourth in that they are simply cellulose which has been altered by various chemical processes, but finally reaches the market as regenerated cellulose: the last, the newest comer to the world of textile fibres, is a chemical compound of cellulose with acetic acid.

In Chapters III. to V. the viscose process is treated in considerable detail; the flow sheets that are given for each process are very useful in showing the stages of the production. A special word of praise is due to the illustrations, both the plates and those in the text, which are adjacent to the reading matter that deals with them; thus the picture is under the eye for reference just where it is wanted. This good point might well be copied by other publishers. The description of the manufacture of viscose is so clear and comprehensive that it might almost serve as a textbook for those who contemplate making this material, and will also probably prove useful to those already engaged in the industry.

On page 25 the author introduces yet another system for estimating the size of Rayon yard, which, like silk, is expressed in deniers; he calls it the Italian or legal system and gives it as the weight in milligrammes of 9 m. of yarn. It is perhaps more usual to give it as the weight of 400 elles or 450 m. in half decigrammes.

Naturally, the size of the jet through the holes in which the filament is spun is a matter of extreme importance, and as the passage of the solution through the minute openings tends to make them larger there is an apparatus for showing a magnified view of the jet on a ground glass plate of such dimensions that any irregularity may be readily detected. The vexed question as to the superiority of the spinning box over the bobbin spinning machine is still unsettled, but the author appears to be somewhat in favour of the former. It is interesting to note in passing that Topham's original model spinning box, which is made of glass, is in the Applied Chemistry Section of the Science Museum. The increase of fineness in the threads produced during recent years has been very marked, and mention is made of Bronnert having made viscose filaments measuring 1·25 denier.

The many processes through which the artificial fibre must pass, between the spinning and the finished hank, are described with much detail, and there are many good illustrations of the machines employed in the various stages. The cuprammonium process consists of dissolving cellulose in a solution of copper in ammonia, and after spinning of recovering the copper, leaving only the regenerated cellulose. This method is not, at the present time, of great importance, but as the fibre produced is of very fine quality there is a gradually increasing demand for it. It may be obtained in a much finer condition than any other make; filaments can be made by the stretch-spinning system of a fineness of 0·5 to 0·6 denier, which is about the same size as the filament of silk. In the description of the nitration of cellulose for nitro-Rayon it comes somewhat as a surprise to find that the old "pot" system is still in vogue in foreign countries; it might be thought that in these days of price-cutting this wasteful process would have disappeared. The mention of bronze blades for pulping beaters instead of steel is also surprising. Unfortunately, there is only a passing reference to the very interesting subject of the recovery of the solvents in this process; it is upon this that the commercial success of this kind of artificial fibre rests. It was the nitro-cellulose filament spun and denitrated by Swann in 1883 that was improved and made a practical success by the late Comte de Chardonnet in France. Now it is no longer made there and has returned to its native land, where the production, though small, is increasing.

The rapidly growing cellulose acetate manufacture, which has been so largely in the public eye during the past year, is dismissed rather curtly, and several other fibres which are not of present commercial importance receive passing mention. One of the objections to the artificial fibres offered a year or so ago was their hard, metallic glaze, which showed up badly in contrast with the soft sheen of silk. It has been the successful aim of the chemist so to reduce this glaze that the material now being sold very closely resembles silk in this respect; it is stated by some authorities that the most recent products cannot be distinguished in appearance from the "Queen of Fibres" even by experts.

There are several interesting plates of micro-photographs of cross sections of varieties of Rayon—one of which is missing from the review copy—and they are described in reference to the very important subject of the covering power of the fibre when woven into fabrics. In the table on pages 89–90 showing comparisons of tenacity and elongation of various sizes of fibres silk is mentioned, but as the size of it is omitted a useful comparison cannot be made.

On the subject of dyeing, after dealing with the probable causes of unevenness of shade, the author recommends dyeing the batch, sorting out the dark skeins and then stripping them; surely this is a dangerous practice and unnecessary. It rather suggests making a patient ill for the pleasure of curing him. The "Icyl" colours, which are said to be specially good for viscose, receive only passing mention, although the makers have published full information about them. Detailed instructions for dyeing with other classes of colours are given; the amount of alkali recommended for use in the sulphur dye bath would seem to be dangerously high.

In a very brief sketch of the uses to which these artificial fibres are put it is stated that ramie is being replaced in the knitting of incandescent gas mantles. Hollow fibre, staple fibre and imitation wool are spoken of, with some allusion to their commercial uses. The cuprate variety is also appearing as Monofil, or single-filament yarn, as opposed to the ordinary yarn made by twisting together a number of filaments. It is being used for braids, laces, millinery, pile carpets, hair nets and wigs. Imitation straw can also be prepared for hat manufacture.

In dealing with the economics of Rayon it is pointed out that in spite of the phenomenal increase of output during the past two or three years it is at present only 2 per cent. of the total combined output of commercial fibres, and though it is hinted that the market has as yet been scarcely touched, it is not likely that the standard fibres, such as cotton and wool, will ever be replaced for clothing purposes, unless the artificial material can be made much more cheaply and with greatly altered qualities.

In 1913 the four principal producing countries were Germany, England, France, and Belgium. They are now America, Italy, Germany, and England. As home consumption is being satisfied in the majority of places considerable quantities are becoming available for export, and there are usually tariffs to meet this; consequently a big battle is being waged for supremacy in the Asiatic and South American markets. The reason for the great increase in the production of viscose as compared with the other kinds is the cheapness of the raw materials: wood pulp, caustic soda, and carbon disulphide.

An appendix to the volume gives details of tests of the ingredients of viscose and the finished product. There is a useful index.

BOOKS RECEIVED.

The Future of Tin. By H. Oakley and E. Pritchard. London: St. Catherine Press, Stamford-street, E.C. Price 6d. net.

A Text-book of Telegraphy. By A. E. Stone. London: Macmillan and Co., Ltd., St. Martin's-street, W.C. 2. Price 20s. net.

A First Course in Experimental Science for Technical Students. By R. W. Hutchinson. London: University Tutorial Press, Ltd., High-street, New Oxford-street, W.C. 1. Price 4s. 6d. net.

SIXTY YEARS AGO.

AN early anticipation of the fundamental principle of the modern cinematograph is clearly indicated in a note which we published in our issue of May 8th, 1868. Professor Pepper, of the Royal Polytechnic Institution, a gentleman who had established fame for himself by his "ghosts" and other optical illusions, had devised a new optical lecture "of high-class scientific character and full of remarkable experiments." Most of these experiments, we recorded, were founded on the principle of the persistence of vision. One illustrated the application of the "Wheel of Life"—then a new toy—to the magic lantern. A glass disc with figures painted near its circumference was made to revolve rapidly in front of the condensers, and by an arrangement of lenses in front of the disc the pictures were projected in rapid succession upon the screen. We read that the effect was to show a little boy and girl playing a very grotesque and lively game at leap frog. Professor Pepper also exhibited the "photodrome," a device invented by Mr. Rose, of Glasgow. This device was a clear anticipation of one form of the modern stroboscope. A disc with two slits at opposite parts of its circumference was rapidly rotated in front of an oxy-hydrogen lantern. The two flashes of light transmitted through the slits at each revolution of the disc were thrown upon a wheel with spokes, which could be rotated at a high speed. As the frequency of illumination was increased, the wheel appeared to change the number of its spokes, to stand still or to revolve in the reverse direction to the actual. In the same issue our Paris correspondent reported that the Emperor of the French, in conjunction with M. Dupuy de Lôme, was studying a new system of shipbuilding which was being developed under conditions of great secrecy. A 20ft. model had been built, and it was reported that the construction of two war vessels then on the stocks had been stopped in order that some or all of the features of the invention might be incorporated in their design. What the invention consisted of we did not know or did not record, but we stated that the model presented extraordinary novelties in its build, armour-plating, machinery, and steering apparatus. The Emperor, with his house just about to take fire, was, it seems, also fiddling with another idea for the improvement of ship-building. This invention, the product of Monsieur Béléguic, consisted of a new form of hull, which was to be driven upon instead of through the water—an anticipation apparently of the modern hydroplane or speed boat. The dispatch boat "Renard," a vessel displacing 800 tons, had, it was recorded, been fitted with the invention, and with engines of only 150 horse-power had achieved a speed of 13 knots with steam alone and of 14 knots with steam and sail. With vessels of different form speeds up to 20 knots were anticipated.

THE PAUGAN FALLS POWER PLANT ON THE GATINEAU RIVER, QUEBEC

(For description see opposite page)

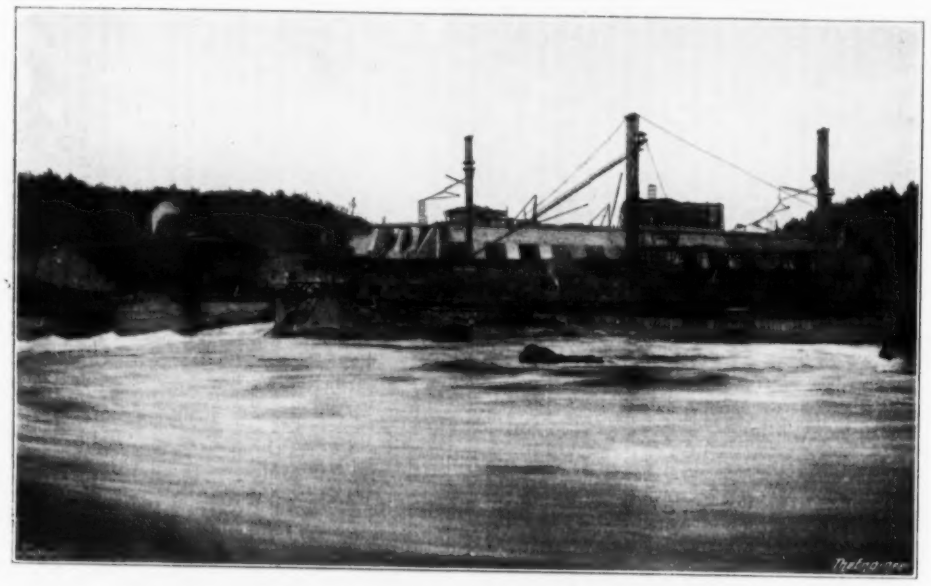


FIG. 1—DOWNSTREAM SIDE OF POWER-HOUSE AND MAIN DAM

FIG. 2—DOWNSTREAM SIDE OF WEST END OF MAIN DAM

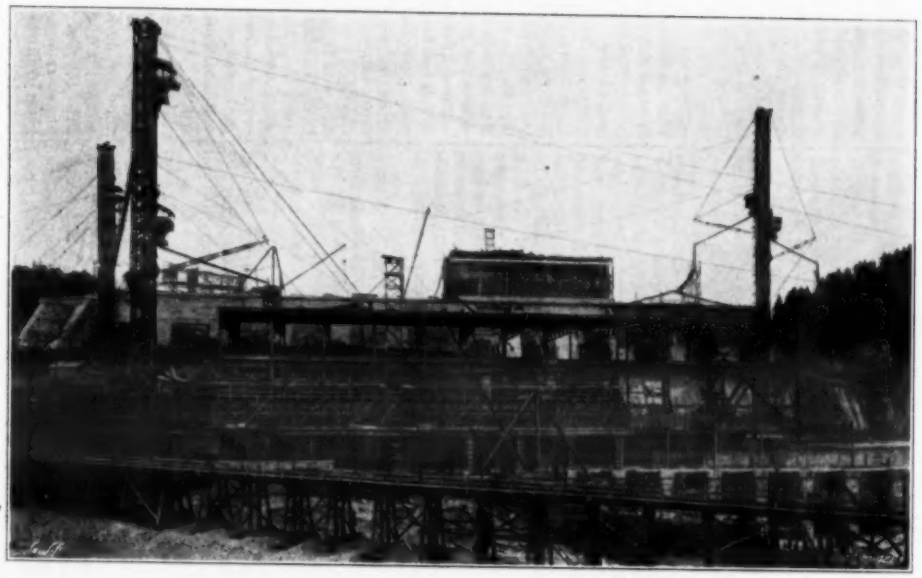


FIG. 3—DOWNSTREAM SIDE OF POWER-HOUSE

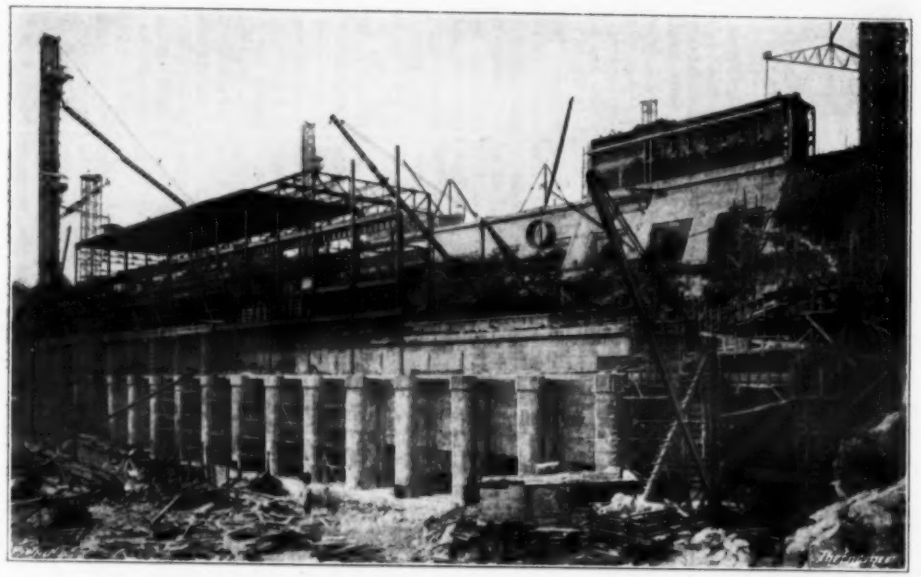


FIG. 4—DOWNSTREAM SIDE OF POWER-HOUSE AND EAST END OF MAIN DAM

The Paugan Falls Power Plant.

ONE of the largest hydro-electric enterprises on the North American continent—the Paugan Falls plant of the Gatineau Power Company, on the Gatineau River, in the province of Quebec—is rapidly nearing completion. This project is part of a unified plan for the intensive development of the power and wood resources of the Gatineau River. It is the third super-power plant that the Gatineau Power Company is installing on this river. Two other plants, one at Chelsea and the other at Farmer's Rapids, have been completed. The Paugan Falls plant is designed for an ultimate capacity of 470,000 horse-power, and an initial output of 272,000 horse-power. Provision has been made in the dam structure for fourteen 17ft. penstocks, and eight of them are being installed at present. This capacity makes it one of the major power plants of the world. It is probable that Paugan will supply most of the 260,000 horse-power called for under a contract with the Hydro-Electric Power Commission of Ontario, though all three plants will be inter-connected to provide against inequalities and emergencies. The Paugan transformer station will distribute directly to the Commission's transmission lines, and if at any time current is needed from the other plants forming the system, it will be stepped up from 110,000 volts to the voltage required.

The Paugan plant—Fig. 5—is situated 32 miles above the mouth of the Gatineau River. A dam being built below the falls will back the water up to Chute Calumet, a distance of 30 miles, drowning out nine falls and rapids and creating a head of 136ft. Above Paugan a mile of fast water, in which the river drops 30ft., terminates in a small rocky pool. From this pool the river flows over Paugan Falls, a sheer drop of 28ft., into a short narrow gorge, at the foot of which it divides into two narrow channels, which empty into a large shallow basin. The walls of the gorge are very steep, on the east side rising almost perpendicularly for more than 100ft., and are flanked by high rocky hills.

The main dam is in the gorge a short distance below the falls, and runs across the hill on the west side to higher ground beyond. It contains two regulating sluices, each 20ft. wide, and the intake for fourteen turbines. The maximum height of the dam from the bottom of the gorge to its crest is 165ft. Some distance above the falls, a sluice dam—Fig. 7—is being built in a natural depression in the hill flanking the river. This dam contains a log chute and six sluiceways, 50ft. wide, provided with Stoney sluice gates, and discharges into the basin below the gorge. It has been designed for a discharge capacity of 120,000 cusecs at high water. The power-house is situated at the foot of the gorge, the turbines being connected to the intakes by steel penstocks, 17ft. in diameter—see Fig. 6. The superstructure contains the settings for eight units, each unit having a rated capacity of 34,000 horse-power at 132 ft. net head and 125 r.p.m.

The general topographical features of the site were such that the possibilities of development on a very large scale were not easily apparent, and a great many difficulties presented themselves. In the first place, there was the question of cofferdamming the narrow stream bed at the falls, which would force the stream through a very narrow channel. There could be no diversion of the stream to other natural channels, as it was entirely blocked by high land, except for the gap at the falls. There was also the question of a satisfactory overflow arrangement, which the general lay-out of the site rendered difficult. The question of stream diversion was overcome by cutting a by-pass through a transverse granite ridge about 800ft. to the west. The head of the falls was cofferdammed, thus diverting the river through the by-pass, which is large enough to carry 30,000 cusecs.

About 2000ft. to the north-east another channel has been cut through a lower-lying section of the surrounding ridges, and there the overflow gate section is being built.

The main dam is about 1000ft. long. The ridge already referred to forms a very considerable part of the dam; but, as it is not high enough to give the level required, it is topped by a concrete structure into which the penstocks are built. The forebay level at Paugan will be approximately 460ft. above sea level, while the tail water elevation will be 325ft., giving an effective head of 135ft. The original water level above the falls was about 360ft. Thus it will be seen that the Paugan dam will raise the water about 100ft. This will create a lake about 5 miles long. The building of four small dams to prevent the diversion of water through low-lying sections of the flooded land has been necessary.

The construction of the by-pass was one of the first jobs tackled. The rock excavation amounted to 90,000 cubic yards. The channel has been concreted and bridged, and will remain a permanent feature, as it will serve as a spillway canal. It consists of two openings, each about 20ft. by 36ft. under the base of the dam. The whole of the Gatineau River is diverted through these two openings at the present time. When the installation is completed, the two openings will be gated and used for regulating stream flow during the filling of the Paugan pond, after which they will be plugged with concrete, and the channel used to conduct the overflow of the small spillway—the only one at the Paugan development—that has been constructed at this point.

The main cofferdam is of the usual crib form, but it is faced with concrete, and has been specially weighted with the same material. The foresight that entered upon this type of construction was very amply justified last fall when the river rose to an unprecedented height after a torrential rainfall. The by-pass was taxed beyond its capacity, and the water overflowed the main cofferdam, and but for its specially heavy construction, the latter would have been carried away. The overflow section of the project consists of a system of massive piers, which will carry the sluice gates. There are six 50ft. openings. The structure is built on limestone, and the foundation apron is carried downstream a good many feet to prevent backwash erosion of the soft rock. Here also is arranged the log slide, which is built of concrete, and which will discharge into the basin below the tail-race.

The power-house is being built of steel and brick, on a concrete substructure. It will be approximately 500ft. long by about 100ft. wide, and will house at first eight 34,000 H.P. units. The generators, which will be of the vertical type, will be supplied by the Canadian Westinghouse Company, Ltd., and the transformers, which will be outside, will be made by the Canadian General Electric Company, Ltd. The turbines will be made and installed by the Dominion Engineering Company, and penstock gates will be supplied by the Dominion Bridge Company, Ltd.

The task of mixing and pouring concrete for this project was a big one. All the concrete was mixed in a central mixing plant, which was situated just west of the by-pass channel. This plant was housed in a very high and strongly constructed building. It had to be high to provide for huge storage bins for raw materials above the mixing plant, and for storage of mixed concrete below it. It had to be strong because loaded trains of stone and sand ran on its superstructure. Sand, crushed stone and cement were all stored in bins and measured automatically into four Lakewood 1-yard mixers. The mixers discharged into hoppers, which, in their turn, discharged into the work trains. These distributed the concrete to three towers, which were equipped with counter-weighted cantilever chutes, which fed the concrete in continuous streams to various parts of the job.

A feature of the concrete distribution was a 2000ft. aerial cableway, which was used for transporting concrete from the central mixing plant to the overflow and sluice section. Eighteen ¾-yard buckets operated on this cableway, and their operation was continuous.

To make the Gatineau River yield its maximum potential power, the flow had to be more or less equalised by impounding a measure of the great volume of water liberated by the spring thaws and by releasing it during the low-water period in the summer. This led to the creation of the Lake Baskatong storage system—an engineering feat of the first magnitude. Lake Baskatong is about 120 miles up river in a region that forms a natural basin for the impounding of water. The key of the entire system is the great dam at Bitobee, which, when closed, will create a lake with an area of more than 100 square miles and capable of impounding 82,000 million cubic feet of water for use during the low-water season. It is expected that the regulated release of this water will result in a normal flow of about 10,000 cusecs.

On page 522 four views of the works are given; they were all taken from the downstream side. In Fig. 1 the power-house and west end of the main dam are shown, whilst on the left the diversion channel can be seen. The diversion channel and the west end

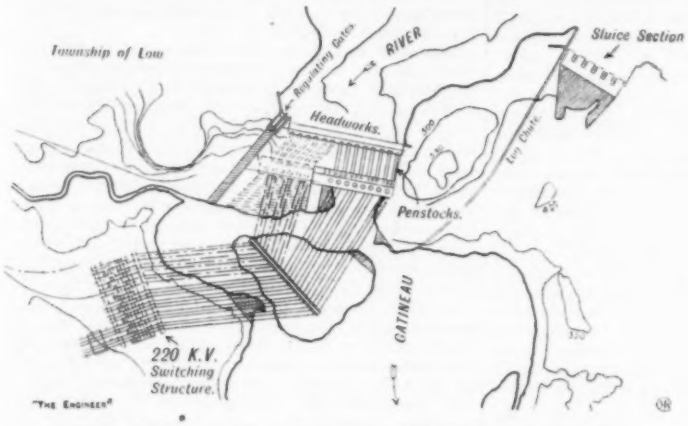


FIG. 5—SKETCH PLAN OF PAUGAN FALLS POWER PLANT

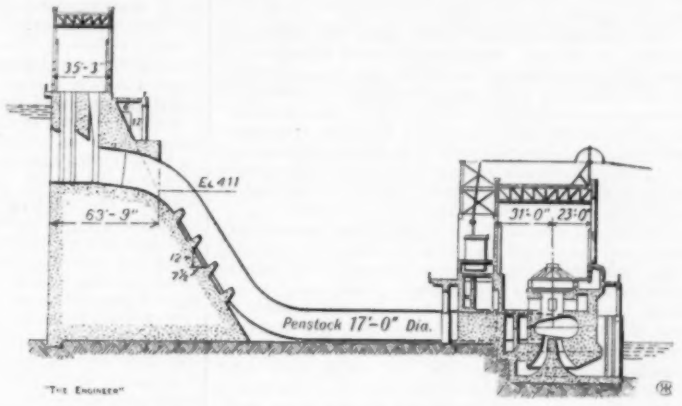


FIG. 6—SECTION THROUGH PENSTOCK AND POWER HOUSE

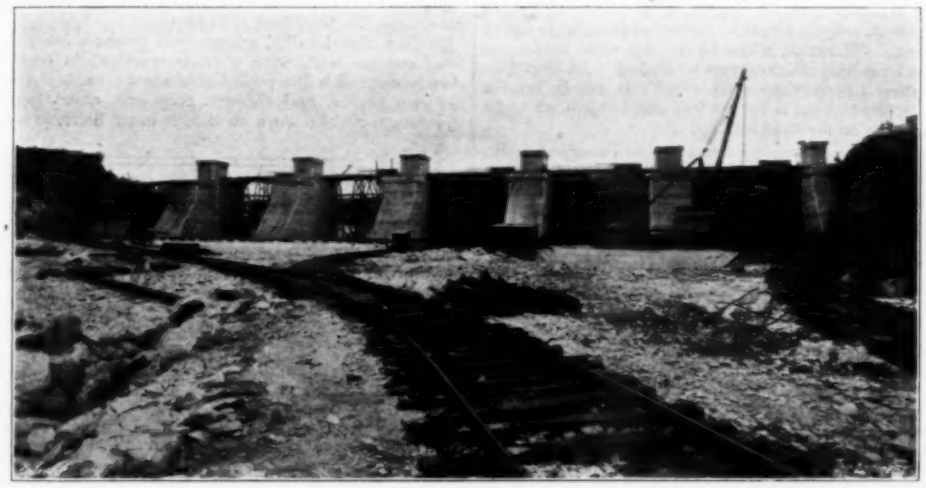


FIG. 7—SPILLWAY DAM ABOVE PAUGAN FALLS

of the main dam are seen also in Fig. 2, in which the beginnings of the power-house can be seen on the right-hand side. In Fig. 3 the skeleton of the power-house can be seen in front with the main dam rising behind it; whilst Fig. 4 gives a still clearer idea of the relative positions and sizes of the two structures.

Over the Staff Manager's Shoulder.

By F. W. B.

THE number of youthful applicants interviewed by the average employer or staff manager during a year runs into scores, and in many cases hundreds. It is both interesting and important to consider the responsibilities these men incur, not only when they are actually "weeding-out," but throughout the time the lads are in their employ.

The question depends chiefly upon the employer's outlook on things. Analysing his own thoughts, he may look upon himself merely as one who, according to his inclination may, or may not, use the labour of a certain individual; he will quickly "size a man up," accept or reject him, according to what experience tells him that labour is likely to be worth, and the cost of it, and there the matter ends. An unfortunate method, but often unavoidable because of the rush of applications to be dealt with.

On the other hand, if he is something of a psychologist and longsighted as well, he will, if he possibly can, "make time" in which to choose, not simply the right man, but the "rightest"—from every standpoint. And by that extra care he will benefit his firm, the applicant himself, and, more important than either, his profession. Although many will say it is impracticable, even foolish, to select with such idealistic objects, the plain truth is this: in these days when the engineering profession is becoming saturated, every employer shoulders a very heavy responsibility indeed with every fresh "hand" he employs. Simply because, by his indifference or care, he may produce either another addition to the mediocre rank and file, or a "real" engineer—one who will hold his profession dearer than many things, and who will judge his own progress, not by what he gets out of it, but what he brings it.

Every user of youthful labour holds the nucleus of a future generation in his hand, and if he is worthy and cares for the future of engineering—not only the present, of which he is a part—he will "sift" those applications critically, and finally select with a dual object. It is his job as a business man and an engineer to make his products as perfect as possible; he takes pride in a neat assembly; he will go "all out" to maintain a reputation for reliability. And it is his duty as an employer so to mould the units of his staff that his hall-mark on them shall be known and respected, and that when he has finished, men of his making, built and trained for one purpose—the honour of his and their profession—will "carry on."

The man, with his machine, makes the article, but the employer can make a man, and to that end also he must select his material.

Now, there is a great difference between training a boy and merely handing out more or less complete information about evening classes, paying his fees—if he wants to go—and giving him time off, if necessary. Many firms do all this and it is to their credit, so far as it goes. But the trouble is this: these privileges are usually granted on the condition of regular attendance and reasonable progress at classes, and in such cases no responsibility rests either upon the student—beyond satisfying those two conditions, which means little—or the employer, beyond payment of fees.

Why is it that, in the case of unindentured apprentices at any rate, employers do not take a keener interest in their studies, keep in touch with their real progress, and ensure that on their part they give of their best? The answer, presumably, is this—and it is a reasonable one: that the employer knows very well he cannot hope to find work for all these men of his when he has produced them, because with the present unemployment list on the one hand, and the yearly exodus of first-class men from the universities on the other, the best advice he can give any lad, from the simple point of view of earning a living, is: "For your own sake, don't come into engineering; there's no room for you." He cannot say that, so he does what is usually considered a very good "next best thing."

And now I want to suggest an alternative for the consideration and criticism of those who are in a position to judge its worth.

First, when a number of youths come to you for a job, choose, naturally, one who is well fitted to fill your vacancy; but also choose the boy for the meanest position almost as carefully as you would engage a personal assistant. After all, your personal assistant will probably remain so until he leaves the firm or steps into your shoes, but in the short time of two years you can make anything or nothing of a grimy little lad.

Then, having chosen your man, both for his abilities and his possibilities, give him frankly this choice. On the one hand, while carrying on with the usual routine of the shops, he shall attend such evening classes as you will tell him are absolutely necessary in order that he may understand his trade thoroughly, for which you will pay; do sufficient homework in the evening to take him through a few elementary examinations; work as hard as the next fellow in your time; and for the rest of his day play well. Granted that he keeps to this programme and keeps his eyes open when working with the men, you can safely promise to turn him into a good workman.

On the other hand, tell him he must first raise himself to a certain level of general education—say, matriculation standard—as soon as he possibly can, and then get down to the work of becoming a "real engineer." Tell him he will have to commence a long series of lectures, possibly extending over six or seven years, and buy or borrow innumerable books, and swat. That after a hard day's work, he will have to sit down and study from, say, six o'clock to somewhere near midnight, getting in an extra hour in the early morning if he can; that he will have to work always, on Saturday afternoons and most of his "odd" holidays. Tell him what all this may do to his health and to his sight. Give him an idea of what a grind it is in college; tell him he must aim at the standard he would have reached had he gone there.

Tell him that if he chooses the first he will have the same chance as another of earning his 1s. 8d. or so an hour by the time he is twenty-three—before, if he is lucky—and with most of his "book learning" behind him. Also that if he chooses the second and qualifies at about the same age he will be in a position to take a job as junior assistant at £2 a week, and still studying, and that whichever he does it is largely a matter of sheer luck whether you or anyone else will have a position worth taking when he is ready for it.

Tell him all this and give him a week to think about it; then, according to his decision, you have him, mechanic or engineer, and according to that train him.

Assume, then, two lads, who have chosen differently; then the first problem you have to face is the obvious fact that these two are going through your works, side by side, doing the same sort of work, receiving the same pay, on the same status. And the temptation to favouritism, not outwardly, of course, but in your own mind, is avoided at the start if you accept this as a simple truth: that you are not the one to judge which of the lads is using his life to the world's best advantage, whatever your private opinion may be. It therefore follows that your influence must exist, in the main, not during working hours, but after they have reached home. That is not surprising, for during the day they must work with the older hands in the usual routine and take care of themselves. In fairness to everybody, including themselves, conditions could not be otherwise.

Consider first your young mechanic; his case is the simpler, though no less important. Unless he has come from a trade school or another firm he cannot be expected to choose his own branch of the trade immediately. But for the first few months there are three "safe" subjects you can advise him to take: elementary mechanics and mathematics, sufficient to give him a thorough grasp of the meaning of "speed," "head," "work," and so on; drawing—in later years especially, his rough sketches will be clearer and far more concise than his explanations; and, if I dare suggest it, a little English, including the gentle art of writing. Of course, when he decides what to do you can advise him what classes to attend. All this does not affect his daytime work at all; it will be no disadvantage to him if he studies one subject at night and works on another all day.

As I have said, many firms already carry out this programme, or improvements upon it, and indeed, so far as the potential workman is concerned, only one thing is lacking in the arrangement as I have outlined it; but that one thing is the salt, a kindly personal interest on the part of the "gov'nor" himself, or at any rate those of his assistants whose duties carry them into close contact with the men. The really great men are always gracious, and we all have the power of being a little great. Every boy has some good in him, but sometimes considerable excavation is necessary, and that is not always his fault. Later, his weaknesses may be your fault, not even because in the eyes of many you should have helped, but simply because you could. Therefore, follow your man up in his home studies as conscientiously as you do in his shop work; tread on his heels when he needs it; but when he does require shaking up, be sure you do shake him *up*, and not by indifference, or worse, by sarcasm, sicken him of work and of you as well.

The potential engineer must have a background into which he can fit his technical acquirements, and, if necessary, and if he is young enough to spare the time, he should give up two years or more of his home work to "prep." In the light of recent events one would hardly erect a power station in Cornhill; you cannot build an engineer from an intellectual shell.

Two things are required: first, the student should pass a good public examination—I have already suggested matriculation—and second, he should make a habit of reading at least one book that is worth while every week. I have neither the time nor the space now to deal with the worth of these, but to the engineer a book by a great man brings home the value of calm, self-control, clear thinking, tolerance, the true simplicity of a hard-working life, and, greatest of all gifts, sincerity. The books you will suggest depends upon the intelligence and habits of your beginner; he may need to be lured from twopenny thrillers to the things that matter. Dickens, Goldsmith and Shakespeare form a congenial route, and if they lead later on to the true appreciation of Ruskin they will not have been unworthily used, while you will earn the lifelong gratitude of the man you helped to wake up.

He should be not older than nineteen when he commences his technical training. For an elementary schoolboy the three preceding years will have been stiff ones, and his reaction to the demands made of him will tell you whether he is capable of making good or not. Those three years are of vital importance; during them he has been given an insight into things which to most lads from a certain class are the "frills" of life, not the necessities; and during that time he will have opportunity to change his mind and take the easier course. If the fault should be downright laziness, cure him; in that case only have you the right to criticise his action.

But assume that he now commences a thorough course in his selected branch of engineering. In London and most large towns the City and Guilds' diplomas are, of course, well enough known, and proper institutes are available, or he may obtain a pass-out certificate from a local college for evening work. There are many, however, who are either unfortunately situated or for some other reason are unable to do this; for them—to introduce a controversial subject—the correspondence schools are open, provided always that the course involves a public examination at the end of it; otherwise, for a young student, it is almost useless.

In either case, if you know the youngster to be satisfactory in other respects and can show him to be under your care and definitely training as an engineer, you will be able usually to enrol him as a student of one of the engineering societies. In that case he may frequently elect to study on his own for his associate membership examination, adding such subjects or such lectures at evening classes as you may deem advisable. He will receive the benefit of the Institution *Journal*, or he will later, at any rate, when he can read it, and of any meetings or visits he can squeeze in. But a point little realised is this: he will gradually begin to feel "like an engineer," and he will have to live up to it. And all the time he has the very helpful knowledge that, although you cannot be expected to give him a "job" as soon as he wants it, you are there and his progress really does concern you. So that in front of him there is the great attraction of a wider world, to which through his Institution he really "belongs," and behind him you.

Going back rather a long way, I remarked that both the would-be mechanic and potential engineer have to pass through your works, for a number of years probably, literally rubbing shoulders, and now I have apparently evolved two entirely separate classes, with all the attendant evils of "distinction." But the last does not follow at all. Granted only that neither is a snob at heart, there need be no friction; each was offered his choice in the first place and either may change his mind. Their status is one during the day, and your influence on their private work is unbiassed since you are simply helping to bring out from each the best that is in him.

In fact, the detailed scheme you produce from this brief outline will, with a little worthwhile trouble closely approach the practicable ideal; each chooses his own career, and there is only one restriction—that whatever the work chosen, it must be done well.

A Model Drawing-Office.

WE recently had an opportunity of inspecting a model drawing-office and printing-room which has been organised at Shell Corner, Kingsway, London, by B. J. Hall and Co., Ltd. Incidentally, we gleaned some particulars of a new process for making positive prints from tracings which greatly simplifies the apparatus required.

The idea underlying the institution is, we understand, to elevate the conditions under which much drawing-office work is done and to inculcate a habit of orderliness which is absent from many drawing-offices. Mr. Hall suggests that an architect, for instance, may spend a great amount of time and money on the preparation of a plan, and then dispatch it to the nearest or cheapest office for tracing and printing, regardless of the fact that it may be handled indiscriminately with other work, and may even come to the knowledge of undesirable people. He claims that no very great expenditure need be entailed in improving drawing-office conditions, and that the outlay will be well repaid by the better care bestowed on drawings and tracings, regardless of whether the office is public or private.

In the drawing-office at Shell Corner, there is displayed a variety of drawing boards, some fitted up with draughting machines and others with parallel rulers, while one is arranged on an ingenious stand which allows the board to be put into practically any position at any height. There are also chests of drawers for the storage of drawings, and bookshelves all arranged in an orderly fashion. In connection with the office, the proprietors are organising a reference library of manufacturer's catalogues, to which anybody interested is welcomed. The catalogues are all bound in standard covers and are classified for easy reference.

The printing-room adjoins the drawing-office, and is employed in commercial work, so that the operation of the plant may be conveniently studied. It is a big airy room and the manager boasts that from it a finished print can be delivered two minutes after the arrival of a tracing.

The equipment comprises a continuous electric copying machine, similar to that described in THE ENGINEER of November 18th, 1921, and another of the vertical type. There is a developing bath for blue prints, a continuous drying machine, a drying oven for cloth prints, and a guillotine trimmer. Besides these machines, there is a gelatine table for "true-to-scale" printing, and several other tables.

The continuous drying machine has a hollow cast iron drum mounted on trunnions, and is heated internally by gas jets. It is driven by a little electric motor, and the speed can be adjusted. Round about two-thirds of the circumference of this drum there is wrapped a heavy cloth band, which also passes over four guide rollers, so that it is returned, round the back of the machine, to the starting point again. The print is fed in between the drum and the band at the bottom, and is delivered at the top. It is then guided into a trough below; consequently, once a print has been started in the feed, it can be left unattended. The output of this machine is eighty double elephant sheets per hour on a consumption of 35 cubic feet of gas per hour. The roll can, of course, be heated electrically if desired.

The other appliances in the room are sufficiently familiar to engineers to need no description here, but the new process of printing is interesting. It is a development of the Coralin print, which Messrs. Hall have employed for some months. The Coralin print has a purple line on a white ground, but the new Ilex process—it is only a few weeks old—gives a dark brown line on white.

The inventors, naturally, do not wish to disclose the chemical formulæ concerned in these processes, but they tell us that the preparation of the papers depends upon the formation of an insoluble dyestuff in those parts of a print which have not been exposed to light. The actual formation of the dyestuff does not take place until the print is wiped with a developing solution, so that should the emulsion on the paper be in any way destroyed, no formation of a dye will take place on contact with the developer. Light has the power of destroying the emulsion very rapidly and of leaving it colourless, so that by exposing a piece of the sensitised paper beneath a positive original and then wiping the surface of the print with a cloth damped in the developing solution, permanent positive copies are obtained.

We watched several prints made in this way and were surprised at the speed of production. The paper was cut off the roll in a shady, not a dark, corner, and exposed with the tracing in an electric machine in the usual manner. It was then laid on a table and wiped over with a swab soaked in the developer. Immediately, the design appeared and the print was finished. It was only faintly moist, and a rapid passage through the drying machine completely dried it. On testing the dried print against the tracing, we found that it was true as to size within the thickness of a thin line. The process also has the merit of being no more expensive than the ordinary blue print, while it is indelible by most liquids found about the workshop.

A New Pneumatic Tool.

A NEW form of a more or less familiar type of rotary pneumatic motor, which has recently been introduced into this country, is illustrated by the acompanying line drawing. It is manufactured by the Warner Swasey Company, of the United States, which is represented in the United Kingdom by the Rotor Air Tool Company, with offices in Adelaide House, King William-street, London, E.C. 4.

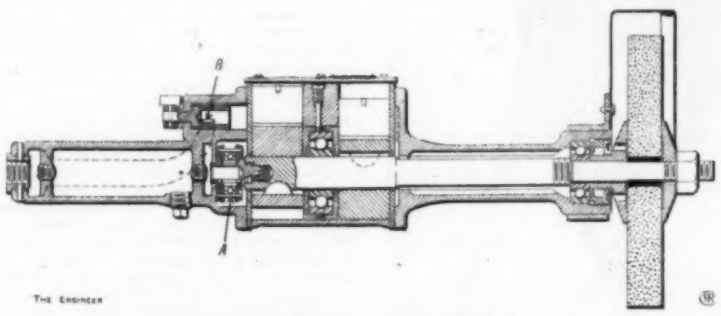
The principle of the machine is that of an excentric, circular rotor, rotating on a fixed cylindrical casing with an abutment or blade to separate the inlet and the exhaust. The pressure air is admitted to the cylinder on one side of the abutment, and, on account of the excentricity of the rotor, drives the shaft round until the exhaust port is reached, when the air is released, and immediately afterwards a further charge of compressed air is received on the opposite side of the abutment. In the case of the machine under review the abutment is maintained in contact with the rotor by the pressure air being admitted to its outer surface, while there are two rotors, set at 180 deg. on the one shaft, so as to avoid any "dead-centre" effect and to balance the rotary parts.

For air-tightness the moving parts rely purely on careful manufacture and a film of lubricating oil. The rotor and its casing, for instance, are both ground to working limits of one-half a thousandth of an inch, while some of the parts are finished to even finer limits. The lubricating oil is provided from a reservoir in the handle, from which it is drawn by the injector action of the incoming air, under the control of a needle valve.

A noteworthy feature about these machines is the provision of a governor to prevent them racing under light load. This governor is shown at A in the drawing, and comprises a pair of spring-controlled centrifugal weights, which control radial ports for the admission of air to the engine. This governor is notable for its compactness, and is, we understand, capable of regulating the speed of the driving shaft within reasonable limits. The controlling throttle valve, which is a simple, thumb-operated affair, is shown at B. It will be noticed that the main shaft is carried by two ball bearings, one of which is situated between the two driving rotors, while the other is near the working head.

Although we illustrate only the machine as a fettling grinder, it has been adapted to a variety of other purposes, such as drilling holes from ¼in. in diameter up to $^{29}/_{32}$in. in diameter, and we understand that a geared set capable of drilling up to 2in. in diameter will be ready very shortly. Other tools have been arranged, with bevel gearing, for driving buffs, &c. Another model, which runs at the high speed of 6000 revolutions per minute, is used in connection with Bakelite, or rubber bonded abrasive wheels.

We have no definite figures as to the air consumption of these tools, but are informed that it is noticeably less than that of a corresponding piston-driven tool. There is also an appreciable saving in spare parts, as the only parts which wear are the abutments, or blades, and they will last for six or seven months in constant service. The tool illustrated weighs 8¾ lb. and is 17½in. long overall.



PNEUMATICALLY-OPERATED FETTLING GRINDER

The Fiat Marine Oil Engine.

IN a paper recently read before the Institution of Engineers and Shipbuilders in Scotland, Mr. D. M. Shannon gave a short history of the Fiat marine oil engine and described its development from its beginning as a submarine engine, twenty years ago. He pointed out that from the very first the Fiat engine was built as a marine engine, and that as its subsequent evolution has been based on sea experience only, it had not encountered some of the troubles which had been met with by builders of land type engines. The designers had, he said, from the very beginning looked with favour on the two-stroke principle of working, a decision which in the light of recent developments was held to have been a wise one. In 1922, Mr. Shannon went on to say, only 15 per cent. of the total output of marine oil engines were two-stroke engines, but at the beginning of this year that proportion had already risen to nearly 50 per cent. The history of the Fiat concern was then briefly referred to by the author, and the early 300 B.H.P. twelve-cylinder petrol engines, designed for the Italian submarine "Foca," described. In 1907 the first experimental direct-reversing four-stroke submarine engine using heavy oil was constructed, and the following year work on the two-stroke design was begun. This type of engine was also built for Governments other than the Italian Government, and four engines were constructed by Scott's Shipbuilding and Engineering Company, Ltd., of Greenock, and were installed in the British submarines "S 2" and "S 3." Further improvements were made, and in 1912 the design was adapted for auxiliary sets. Submarine engines built after this date were fitted with crossheads.

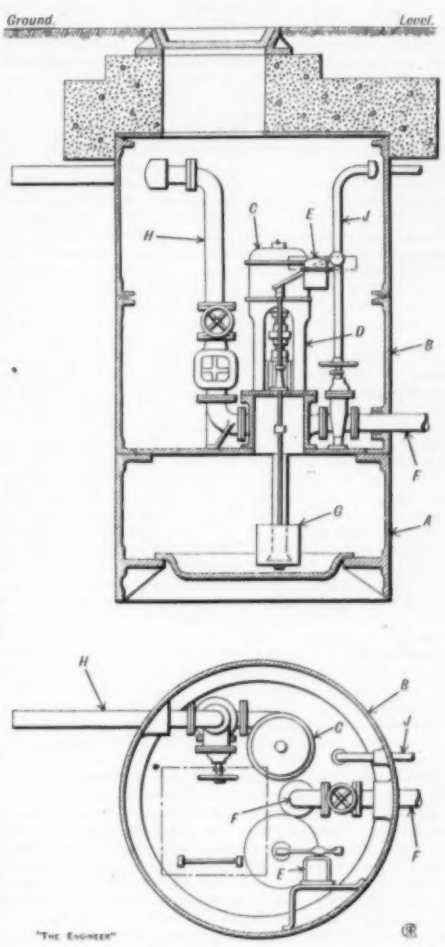
During the war period, work was necessarily concentrated upon standard designs, but in 1923 an experimental two-cylinder engine of the high-speed naval type, developing 400 B.H.P. per cylinder, was built, and using this design a new series of high-speed engines designed to develop from 2000 to 2200 B.H.P. at 380 r.p.m. in eight cylinders was embarked upon. A consumption of 0·435 lb. of fuel per B.H.P. hour was recorded with this type of motor.

The development of the Fiat slow-speed engine dates from about 1910. Notable early engines were those installed in the Brazilian depôt ship "Ceara." They were of the two-stroke type and developed 384 B.H.P. per cylinder against 270 B.H.P. for the largest four-cycle engines then built. Between 1919 and 1921 four cargo ships of the "Ansaldo San Giorgia" type were equipped with 1250 B.H.P. four-cylinder engines, running at 110 r.p.m. These ships have to date each covered about 320,000 miles, corresponding to nearly 32,000 hours' running. Later vessels engined with motors of similar build and design include the "Mauly" of 1925 and the "Maria" of 1926. They are single-screw ships with a four-cylinder engine developing 2200 B.H.P. at 95 r.p.m. The remainder of the paper is devoted to a detailed consideration of the design of this engine, and that of the 2000 B.H.P. single-cylinder experimental unit, of which a description will be found in THE ENGINEER for September 2nd, 1927. Finally, the 450 B.H.P. auxiliary engine, exhibited last year at Olympia—see Supplement to THE ENGINEER of September 9th, 1927—and fitted on board the motor vessel "Bermuda," is described, along with a hot-bulb engine of the crosshead type. The auxiliary engine referred to is now being built by Fiat British Auxiliaries, Ltd., at its Helen-street Works, Govan, Glasgow, and it is interesting to learn that the first engine to be constructed at these works was started up on May 1st, and has been demonstrated for several days. It is one of a series of auxiliary sets which the firm has on order for British shipowners.

Automatic Underground Sewage Pumping Plant.

WE have received from Daniel Adamson and Co., Ltd., of Dukinfield, the following particulars of a totally enclosed underground sewage pumping plant, which that firm has recently devised and patented. The plant, which is claimed to be odourless, and to do away with all buildings above or below ground, and which is illustrated in the accompanying engraving, comprises a cast iron tank A, on the top of which are arranged sluice valves which govern the inflow of the sewage, say, from a low-lying district or a basement, and the outgo from the tank to the nearest public sewer. The wall of the tank A is carried up almost to ground level, so as to form a pump chamber B, and in it are arranged an electric motor C, a non-clogging pump D, and an automatic switch E, these three units being connected mechanically and electrically. The whole thing is arranged below ground level and the hole giving access to it is closed by a cover.

The operation of the plant is as follows:—The sewage



AUTOMATIC SEWAGE PUMPING PLANT

enters the tank A through the pipe F, the displaced air finding its way out through the pipe J. Suspended through a gland in the top of the tank A is a float G, and the arrangements are such that, when the level of the liquid reaches a predetermined level, the spindle of the float G throws over the switch E, thus starting the motor and the pump. The sewage in the tank A is then pumped away to the sewer, or other destination, through the pipe H. As soon as the float G again falls to a predetermined level, the switch is opened, the motor is cut out, and the operation of pumping is suspended until the tank A is again filled when the cycle of operations is repeated.

The introducers claim that this little underground pumping plant is specially suitable for linking up housing schemes with existing sewers, and they point out that, as the sewage is kept under cover all the time, there is no atmospheric pollution. They further point out that any number of these underground units may be installed according to demand, which enables an engineer, when dealing with a flat area, to design his sewers at proper gradients, knowing that if he cannot make them discharge by gravitation, he can raise the unscreened sewage at any required number of places. The plant illustrated is intended for pumping 25 gallons per minute against 40ft. head and it absorbs 1¼ B.H.P. Similar sets are made to deal with larger volumes up to 2000 gallons per minute.

CONSTRUCTIONAL improvements have commenced at Paranagua, an important sea port in the State of Parana, situated about 9 miles from the bar of the main channel. Paranagua forms the port of call for steamers in the coastwise trade and also the coast terminus of the railway running to Curityba, the capital of the state. The works comprise a contract for dredging the bay, which is very shallow and prevents any but steamers of the lightest draught from ascending to Antonina. The operations in hand, which include the construction of dry docks and warehouses, are expected to take three years to complete, and to cost £600,000.

Pulverised Coal.

Up to the present only two papers on pulverised coal have been read before the Institution of Electrical Engineers. The first was presented by Mr. Brownlie in 1923, and the second was read by Mr. F. H. Rosencrants on Thursday of last week. Whereas Mr. Brownlie confined himself exclusively to pulverised coal, Mr. Rosencrants also dealt with mechanical stokers, the title of his paper being "Practice and Progress in Combustion of Coal as applied to Steam Generation." The position of pulverised fuel firing in relation to stoker firing, he said, continued to be debatable and unstable. The efficiencies and flexibility attained with pulverised fuel from the first had been a source of inspiration to stoker designers, with the result that big strides had been made in the improvement of that class of apparatus. Greatly increased combustion rates per square foot of grate surface had been realised, and the control of air supply had been improved. Present-day conditions, however, arising out of the rapid increase in the steam generating capacity of boiler units, the increase in the rate of evaporation per square foot of heating surface, the growing popularity of flue gas preheaters, and the demand for the highest attainable efficiency required combustion rates of 40 lb. to 50 lb. of coal per square foot, with air supplied under forced draught at a temperature of anything up to 550 deg. Fah., and with the excess reduced to a point represented by a CO_2 content in the furnace of 13 to 16 per cent. The result was that furnace troubles were becoming acute. What was even more serious than the cost of repairs were the frequent intervals at which boilers had to be put out of service. In the solution of the problem, water cooling of the refractories, applied both to side and rear walls and arches, was receiving the consideration of engineers. The perfection in combustion with high CO_2 realised at the outset with pulverised coal, produced furnace temperatures which, coupled with the deposit of molten ash on the furnace walls, resulted in heavy maintenance expense, and water or steam cooling of combustion chambers had become an all but universally acknowledged necessity. In the United States many boilers were equipped with water-cooled walls, and practically all the larger installations under construction included water cooling of some form. Activity in England had not been so intense, though a few furnaces with water-cooled walls were in operation, and contracts for others had been placed.

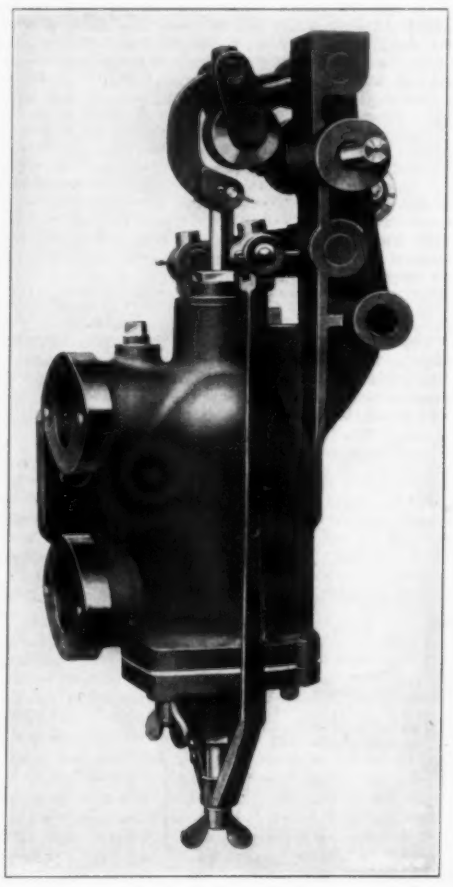
Discussing the two pulverised coal systems that have been developed—viz., the bin and feeder system and the direct firing or unit system—Mr. Rosencrants showed a preference for the former system for large boilers, but in discussing the paper Mr. Chattock contended that some of his arguments against the unit system could not be justified. In the opinion of Mr. Rosencrants, the adoption of the direct fired system for large units is a retrograde step. A curve in the paper shows that the total capacity of boilers equipped with the bin and feeder system in the United States is 49,500,000 lb. per hour, whilst the total capacity equipped with the direct-fired system is 24,000,000 lb. per hour. The curves include all boilers operating and under construction in the spring of 1927, and they were compiled from statistics contained in the pulverised fuel section of the Prime Movers Report for 1926–1927 of the National Electric Light Association.

A good deal was said about the drying of the coal which is necessary in order that the coal may be successfully handled, through the various elements of the bin and feeder system. The drying problem, the author said, could be simplified by the improvement of those elements having a low moisture-handling limit, in order that the limit might be raised to equal that of the best element in the system. The ultimate object should be to perfect the equipment, so that no drying was necessary, and in the large majority of cases that did not seem to be impossible. Theoretically, no heat loss resulted from the drying process, for the moisture in the coal as received either had to be evaporated in the furnace or in the drier. Actually, however, a loss of heat was usually experienced when the coal was dried before it entered the furnace, owing to the inefficient means of applying heat in driers as compared with the efficiency of the heat application in the furnace. In considering the heat required to dry coal in a drier, however, it was important to consider the amount of heat that would be absorbed in the furnace by the moisture in the coal, if it were not removed by pre-drying. Two forms of moisture were recognised, and were commonly designated as free moisture and inherent or hydroscopic moisture. The former was that which the coal gave up when exposed to air at atmospheric temperature, whilst the latter was that which was retained after this exposure and it imparted no sensation of wetness. It was well established that the harmful influence of moisture on the behaviour of coal in the various elements of a pulverised coal plant might be almost wholly charged to free moisture. It was also well established that it was not usually the uniformly distributed moisture which resulted in difficulty, but rather a concentration of moisture resulting from condensation at points where the pulverised product came into contact with inadequately insulated surfaces. It followed, therefore, that the moisture content of a coal expressed as a total gave no indication as to the necessity of drying or the extent of drying required. While some high-grade bituminous coals carrying as much as 6 or 8 per cent. of total moisture might require drying in order to enable them to be handled with any degree of satisfaction, there were deposits of lignite which might be handled with complete satisfaction with as much as 30 per cent. moisture. It could be said with confidence that the drying problem was on the eve of solution; it could also be stated that the steady progress in the improvements in the design of other elements of the system was such that it appeared that by the time dryers were perfected they would no longer be required, save under exceptional circumstances. A drawing in the paper shows a modern pulverised fuel plant. The assembly is fundamentally on a unit basis. Beginning with the raw coal bunker, one boiler unit is served by one pulveriser, one pulverised fuel bin and one battery of feeders and burners. The furnace has been simplified by the elimination of the suspended arch. Drying is carried out in the pulveriser itself with hot air from the air preheater system. At all points the pulverising system is at a pressure below that of the atmosphere, thus preventing outward leakage of coal-laden air. All air withdrawn from the pulverising system is utilised as primary air, and is passed direct to the furnace, thus obviating any possible dust nuisance. Through the interconnection provided by the screw conveyors, the excess capacity of any pulveriser over and above the requirements of the boiler unit which it supplies may be transferred to the bin of a neighbouring boiler. The coal in the bin at the time of a breakdown of a pulveriser, plus any excess capacity of neighbouring pulverisers serving other boilers, greatly reduce the seriousness of a pulveriser breakdown. Through a by-pass equipped with dampers, preheated air may be supplied to the primary air fan without passing through the pulverising system. Thus it is possible to operate the boiler with the pulveriser unit out of operation without inconvenience or sacrifice, and the pulveriser need be operated at full capacity for only such period of the day as is necessary to supply the twenty-four-hour requirements of the boiler.

The "Uniflo" Pump.

The small bucket type of pump illustrated herewith derives its name from the fact that although it is a reciprocating pump it delivers a continuous flow of water without the employment of an air vessel.

The two buckets A B are each fitted with a non-return valve C D. The reciprocation of the buckets is derived from the rotation of a cam E, which acts upon two rockers F G. From the rocker F a link H depends and makes connection with the rod J of the bucket A. A forked link K, passing outside the pump body, establishes connection between the rocker G and the bucket B. A spring holds the rollers of the two rockers in contact with the cam E. The design of the cam is such that during the working of the pump one or other of the buckets is always moving at a uniform rate in the direction of the flow. When the top bucket A is moving upwards, it is drawing water through the valve D into the space between the two buckets

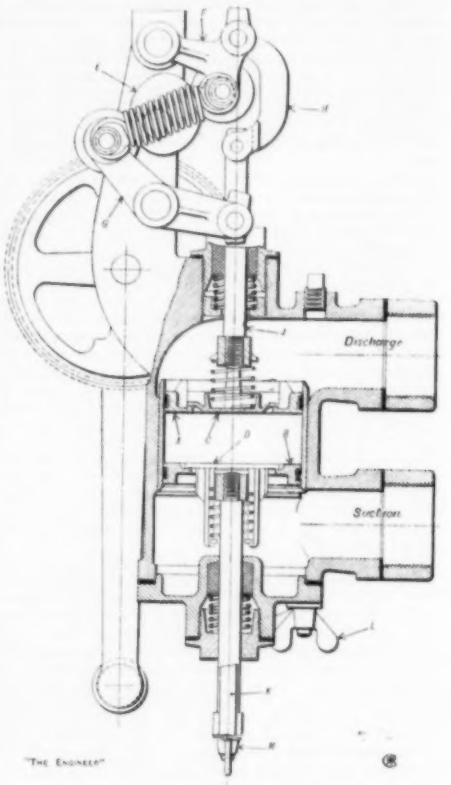


THE "UNIFLO" PUMP

and is delivering the water lying above it at a uniform rate through the discharge. At the same time the lower bucket B is moving downwards. The upward movement of the top bucket extends over a little more than half a revolution of the cam, and just before it is completed the bottom bucket begins to move upward at a uniform rate. The upward movement of the lower bucket now takes up the delivery and discharges the water through the valve C of the descending upper bucket. As in the case of the upper bucket, the upward movement of the lower bucket extends over a little more than half a revolution of the cam, and just before it comes to the top of its stroke the upper bucket begins to rise again. The overlapping period at each half revolution of the cam during which both buckets are moving upwards is designed to give the valves time to close and thereby to eliminate slip and give a continuous delivery.

The pump rods are provided with soft packing compressed by spiral springs. The buckets are of gun-metal, and are packed with phosphor-bronze rings. When the top bucket is in its lowest position and the bottom bucket in its highest, there is very little space between the two, and as a consequence the pump is self-priming to a greater degree of suction lift than is usual in reciprocating pumps. The accessibility of the various parts has been carefully studied. The bottom cover can be quickly removed by unscrewing two wing nuts L holding it in position. When the wing nut M is removed, the cover, the bottom bucket, its valve and its pump rod can be withdrawn from the pump body. By removing the pin at the lower end of the link H the upper bucket, valve and rod can be dropped down and removed.

The pump is claimed to be suitable for dealing with a variety of liquids. It is made in three sizes capable of pumping 150 to 600 gallons of water per hour against heads of 120ft. to 30ft. respectively. It can be supplied either for hand drive or fitted with a belt pulley for driving



SECTION OF "UNIFLO" PUMP

either off a shaft or from an electric motor mounted on a wall bracket, to which the pump is also attached. The makers are the Uniflo Pump Company, Ltd., Fordhouses, near Wolverhampton.

B.E.S.A. SPECIFICATIONS.

STANDARD TOLERANCES FOR REAMER DIAMETERS.

When the British Standard Specification No. 122 on Milling Cutters and Reamers was drawn up and issued in 1920, the Report on British Standard Limits and Fits for Engineering (No. 164, 1924) had not been completed and there had been no opportunity of correlating the Reamer Limits given in Specification No. 122 with those for the Standard Holes. The tolerances for the reamer diameters have now been reconsidered by the Association, and the revised tolerances have been issued as a leaflet for insertion in B.S. Specification No. 122, 1920.

It has not been found commercially practicable to standardise reamer limits to suit each of the standard grades of holes provided for in B.S. Report No. 164, Limits and Fits for Engineering. A compromise has therefore had to be effected, and the Reamer Limits given in Tables XLIII. to XLIX. have been chosen as likely to meet the majority demand from users working to the Standard U unilateral holes, and the Y bilateral holes given in B.S. Report No. 164. Manufacturers generally are prepared to supply reamers to limits other than those given in Tables XLIII. to XLIX. when so specified by the user. Copies of the leaflet of revised tolerances for insertion in B.S. Specification No. 122, 1920, will be supplied gratis by the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, on receipt of a stamped addressed envelope.

The directors of the Great Western Railway have appointed, as successor to the late Mr. R. J. S. Insell, the company's signal and telegraph engineer, his assistant since June, 1923, Mr. Charles Mark Jacobs. Mr. Jacobs is a clever electrical engineer; he was one of the inventors of the audible cab signal system; invented a method whereby the line-clear block signal could not be given unless the distant signal had been put to the "on" position behind the preceding train; and an occupation system for use during repairs to single lines which obviated the necessity for flagmen to protect the operations and a key token instrument for controlling the movements of trains on single lines. Mr. Jacobs read a paper on "Electrical Signalling on Railways" before the Institution of Electrical Engineers on January 10th, 1918, and was the Vice-president of the Institution of Railway Signal Engineers for 1927–28. He would have been the President for 1928–29 of the latter body, but owing to the increased responsibilities caused by Mr. Insell's illness, he asked to be allowed to stand down, and so remains the Vice-president for this year also.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Quiet Conditions.

THE heavy industries of the Midlands and Staffordshire show little improvement and demand for iron and steel is decidedly poor. Seasonal demand is not augmenting the turnover of the mills, furnaces and forges to the extent that was hoped for. The engineering industry, with exceptions here and there in various branches, is only moderately active. In those cases where there are orders on the books which ensure fairly steady employment now and in the near future, new business is not coming in so fast as the old is being despatched. The orders being received are of small dimensions. Pressed steel plants in the Midlands are well occupied, chiefly on motor engineering requirements and the stampers are fairly placed for orders for the same industry. The electrical and chemical sections of the engineering industry report business as moderately brisk. The Birmingham iron market attracts only moderate attendances, and is of a lifeless character. To-day—Thursday—business remained quiet, and there were no fresh developments. The market tone was none too bright and there were no changes of moment in values of either iron or steel. Raw iron of Northamptonshire make was slightly easier, but, generally speaking, quotations were unaltered. The business given out was restricted to small lots for immediate consumption at the works.

Pig Iron.

The raw iron market in the Midlands continues depressed. Demand broadens hardly at all, and blast-furnacemen have difficulty in disposing of their output. Northamptonshire, Derbyshire and Staffordshire furnaces are badly hit by the decline of activity in the pipe foundries, coinciding as it does with an unusually small consumption of pig iron in other directions. On 'Change in Birmingham to-day—Thursday—it was reported that there were substantial accumulations of unsold pig iron at the furnaces. The fact that plants are kept in operation, however, after the expressed intention of smelters to damp down rather than produce for stock, suggests that stocks have not reached unreasonable dimensions. Values are barely maintained. While Derbyshire houses stick to their minimum quotation of £3 3s. 6d., some Northamptonshire furnacemen are reported to have offered supplies at £3 18s., a reduction of 6d. per ton on last week's lowest figure. One thing appears certain, namely, that the resistance of Derbyshire makers is considerably stronger than that of their neighbours, and the gap between their respective selling prices tends to widen. North Staffordshire makers adhere to their figure of £3 2s. 6d. and Scotch and Welsh irons are, if anything, slightly firmer. There is practically no business passing in forge brands, and the prices quoted act purely as a basis for negotiation. It would be difficult, if not impossible, to say what would be the bottom figure sellers would accept for this class of material. It is asserted that the position is, at the moment, worse than it has been at any time during the past eighteen months.

Finished Iron.

The Staffordshire iron mills are fairly employed and producers of best grade bars report the maintenance of the improved business lately recorded. It is thought that the fresh alignment of prices has induced increased confidence in the stability of prices, and that this fact is now beginning to have an enlivening effect upon business. Orders continue to be for comparatively small tonnages, suggesting that the policy so long adopted of buying only for current consumption is being adhered to. The full resources of local mills are not yet employed, but additional plant and labour are gradually being brought into action. Marked bars are quoted £12 and Crown quality bars of Staffordshire make £10. The wide disparity in prices in this department still exists, anything from £9 5s. to £10 being quoted for Crown bars. Lancashire houses compete keenly for the local market, but it is stated there is little business to be had by anyone. Nut and bolt and fencing iron is now fairly generally quoted at £8 17s. 6d., though there are a few makers who maintain that business at below £9 is not worth having and remain firm in their demand for that figure. Belgian No. 3 bars are being offered this week at £6 3s. 6d., delivered in the Black Country. This is a somewhat lower price than has latterly prevailed, but consumers are not purchasing in big tonnages. They are waiting to see what comes of the ups and downs in foreign material before they commit themselves to further buying of any magnitude. Many nut and bolt makers in this district now use steel, having strengthened their machinery for this purpose. Under these circumstances, it is considered likely that this class of foreign material may at no distant date cease to be sold on anything like the same scale as at present for use in the Black Country. Wrought iron gas tube strip is in good demand at £11 per ton and makers are kept comparatively busy. The buying of German tube strip at £6 12s. 6d. to £6 15s. delivered has been greatly reduced.

Steel.

It is not possible to record any general material improvement in the steel trade. The turnover in heavy steel remains disappointing, but some firms report a slight improvement. Structural engineers report increased inquiry for medium-sized buildings, calling for 75 to 150 tons of steel. There is still a marked absence of inquiry for big business. Shipbuilders are taking fair quantities, and good rail orders are forthcoming, both from the railway companies and tramway undertakings. Orders for bridge building material also continue to filter through. Quotations are maintained at recent levels. Angles and joists are £7 17s. 6d., tees £8 17s. 6d., ship, bridge and tank plates ¾in. and over £8 12s. 6d., and boiler plates £11. Staffordshire hoops make £10 10s. at works. Wire rods rolled from imported billets are offered at £8 2s. 6d., and all-British at £8 10s. Small steel bars rolled from imported billets are £7 5s. to £7 10s., against £6 4s. 6d. to £6 6s. 9d. for continental bars. Germany is not so prominent a competitor in this market as formerly. Native billets are quoted £5 15s. to £6, against the £5 12s. 6d. of foreign steel. It is many years since continental prices approximated so closely to British quotations. Continental finished bars are dearer at £6 10s., a price which Birmingham importing merchants are not inclined to pay. Heavy steel founders in the Midlands are doing better business, including the supply of rolls to South Wales. Activity of the Welsh tin-plate trade keeps the heavy scrap market firm. This material is sold at £3 2s. 6d. delivered South Wales, but some sellers ask half-a-crown more.

Galvanised Sheets.

Business in galvanised sheets does not improve, demand both on home and export account being poor. Galvanised corrugated sheets of 24 gauge have settled down on the basis of £13 per ton, but this can hardly be said to be a firm figure. Local mills demand the full £13 for their output, but some of the large mills in other districts have this week shaded their figure in order to secure much-needed business. None of the makers are any too well placed, as is evidenced by the fact that early deliveries are to be had for the asking. Black sheets continue in moderately good request, Midland automobile engineers in many cases placing regular orders. Progress in tin-plates is maintained.

Unemployment.

An increase sufficiently large to wipe out the steady improvement of the past few weeks is recorded in unemployment in the Midlands. Whereas a week ago there were 132,590 persons unemployed, there are now no less than 154,866, an increase of 22,276. It is a most regrettable condition of affairs, especially as the unemployment increase applied to most of the towns in the area. The Birmingham district is one of the outstanding places where during the week the unemployment figures were reduced, the total falling from 24,314 to 24,040. Slight falls also took place at Derby, Leicester and Wednesbury. The Stoke-on-Trent and Walsall areas were responsible for the largest increases, the former one of 2614 and the latter of 1041. Of the total unemployed in the Midlands 121,735 are men, 25,686 women, 4014 boys and 3431 girls. The returns and inquiries made at some of the large factories this week suggest that the major portion of the newly unemployed are only temporarily idle or are on short time, and though the situation is certainly regarded as most unsatisfactory, it is not causing alarm, the opinion being held that the workers will be reabsorbed into industry again in the near future.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

A Proposal and a Protest.

PERFECTLY smooth running is not apparently to attend the proposal to purchase the Altrincham Electric Supply Company, Ltd., by the urban district authorities of Altrincham, Bowdon, Hale and Ashton-on-Mersey—all in Cheshire—and to set up a joint electricity board. The local authorities in the areas concerned, with the exception of Altrincham, unanimously decided in favour of the scheme. Only a bare majority, however, in the case of Altrincham Council voted in its favour. Several engineering concerns are situated in the Altrincham area, and these, together with other manufacturing companies and local traders and property owners, have carefully considered the matter. The result was a town's meeting at which a resolution was passed to the effect that the time was inopportune to proceed with the purchase scheme. It was pointed out that one of the main grounds of objection to the proposal was that no definite statement had been made as to what the purchase price would be, and the contention was made that it would be more advantageous to postpone the idea of buying the undertaking until 1935, when the present agreement with the company would expire.

The Industrial Outlook.

In the course of its monthly survey of general industrial conditions the Manchester Chamber of Commerce "Record," in a reference to the engineering industries, says :—"The engineering trade shows few marked changes. Textile machinery merchants have done a fair trade for export, loom makers especially being busy. Some small firms have been more fully employed than certain big firms. Artificial silk machinery continues in steady demand. Some of the textile machinery which could not be profitably employed in this country has been exported. Constructional engineers, although generally pretty well engaged, speak of inquiries for new work being rather scarce. Makers of milling machinery, lifts, &c., report favourably on the state of their order books, and machine tool makers have experienced an improved demand."

Non-ferrous Metals.

Although still below the level of a fortnight ago tin has recovered much of the ground lost last week. This recovery is due less to any improvement in the demand for the metal from industrial consumers than to a brightening of the outlook statistically, visible supplies at the end of April showing a substantial decline. Stocks of the metal in this country also show a tendency to droop. The full extent of the improvement which was registered at the close of the market last week-end was not, however, maintained in the early days of the present week. The standard copper market has again shown an easing tendency, but as in the previous week the loss on balance is only in the neighbourhood of 2s. 6d. per ton. Refined descriptions of the metal, however, have been maintained. Buying interest in copper, both on trade account and for speculative purposes, has not been active, although there has been a certain amount of buying going on for the cable and manufacturing industries. There has not been much actual buying going on in the case of spelter, but neither have supplies been too freely on offer. In view of the Brussels decision this week respecting output control and other matters affecting spelter this section has shown marked firmness of late. The demand for lead has been only on moderate lines, but prices have been very steady, and, on balance, at the time of writing show no alteration compared with those current a week ago.

Iron.

There has been no change for the better so far in conditions on the pig iron market here, and it is becoming more and more evident that there is room for considerable improvement at the consuming end of the trade. Whilst some makers report a not unsatisfactory call for deliveries against contracts, others have met with requests here and there for a temporary suspension of deliveries. Conditions, therefore, are inclined to be patchy. With regard to the demand for foundry iron this week orders, in the majority of cases, have related to lots in relatively limited tonnages, and for delivery within the next few weeks, with new contracts and renewals, as before, on a very disappointing scale. Under these circumstances a further slight shading of quotations in this section of the market is not a matter for surprise, although only the Midland varieties have been affected, both Staffordshire and Derbyshire foundry irons for delivery Manchester or equal distance being obtainable now at from 71s. to 71s. 6d. per ton, according to quantity. North-East Coast makers are still asking 79s. per ton, and Scottish at from 87s. 6d. to 90s., with West Coast hematite iron selling in limited quantities at down to 83s. per ton. There has been no improvement this week in the movement of local bar iron, but Lancashire Crown quality is fully maintained at £10 per ton and seconds at £9 10s.

Steel.

The most interesting feature of the steel market has been the continued advance in imported materials, both finished and semi-finished, notwithstanding the fact that, so far as this part of the country is concerned, there has been no development in the demand to justify higher prices. Continental steel bars for delivery to Lancashire works for cash against documents are at £6 10s. per ton, wire rods at £6 12s. 6d., Siemens plates at £7 17s. 6d. to £8, Thomas plates at £7 7s. 6d., angles at £6 10s., joists at £6, billets at £5 7s. 6d. to £5 10s., and sheet bars at £5 12s. 6d. With regard to the market for home-produced materials, small bars re-rolled from imported semi-products have a decidedly easy tendency at from £7 7s. 6d. to £7 10s. Other varieties of steel, however, are steady, with ship and tank plates at £8 12s. 6d., sections at £7 17s. 6d., large bars at £8 17s. 6d., and boiler-plates at £9 15s. to £10 per ton, according to quality. Contract buying is still conspicuous by its absence, although altogether the weight of orders being placed is little, if anything, below the recent moderate level.

BARROW-IN-FURNESS.

Hematite.

Makers are experiencing only a moderate demand for pig iron, and there is no tendency on the part of customers to place orders beyond their immediate requirements. There is yet to be exhibited a confidence in the future. There is no sign of it at present. There is a heavier production in the district, and this is to some extent due to restarting of furnaces owing to clearance of stocks. Stocks will accumulate again owing to the fact that requirements for the steel departments are by no means heavy. Business with America is poor, and that with the Continent is meagre, two small part cargoes going to Ghent and Hamburg. Iron ore is in fair demand owing to more production and several cargoes of foreign ore have arrived. The steel trade is quiet, and there does not seem to be any chance of the rail mills restarting at Barrow this side of Whitsuntide. A few orders are held on overseas account, but there is not sufficient to merit a starting up of the mills. The hoop mills are busy and well booked forward. The fish-plate mills are engaged at present. The Anticross iron-ore mine at Dalton-in-Furness, the property of the Barrow Hematite Steel Company, Limited, has been abandoned for the time being owing to the heavy cost of pumping the excessive amount of water in the mine.

Shipbuilding and Engineering.

Shipbuilders and engineers are fairly well situated and likely to be for some time. It will be some time before there is a launch at Barrow, but in the meantime there is plenty of work on the stocks. The purchase of the L.M.S. boats "Antrim" and "Duke of Connaught" will entail a certain amount of alteration work before they are suitable for their new owners, the Isle of Man Steam Packet Company. The "Duke of Cornwall" will be an ideal winter boat for this company.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trade.

ALTHOUGH the general level of employment is being well maintained, the heavy steel trades are finding business extremely dull. Indeed, it can be said that certain operations, such as the production of steel in open-hearth furnaces, the rolling and the subsequent reduction processes are passing through a period of depression. Orders, in fact, are in some cases actually on the decline, and firms which increased their production of steel a few months ago when the high price of continental material forced some additional buyers into the British market, are now finding it a difficult matter to maintain the present rate of working. When the returns for last month are available they will be found to be of a most disappointing character,

and May gives little promise of anything better. Complaints are still freely heard from the makers of heavy material, both crude and semi-finished steel, and also from the producers of large castings and forgings, about the severity of foreign competition, and in many influential quarters pressure is being brought to bear with the object of securing some measure of safeguarding.

Decline in Railway Work.

An important contributing influence to the present quiet state of trade is the decline in railway work of a heavy character. The home companies are buying very sparingly, and appear to be meeting the bulk of their engineering requirements from their own workshops. Nor is colonial and foreign work coming in at all well, and it is here that foreign competition is being met in its keenest form. Sheffield makers, in order to get business, are having to quote figures which can only leave, at the best, a very narrow margin of profit. There is some work in hand for rolling stock for South American countries, many of which still show strong preference for locally made material, in spite of the higher initial cost. It is satisfactory to note, however, when reviewing the general state of railway steel and accessories, that Sheffield and district makers are well holding their own in the production of smaller parts, the manufacture of which has reached a highly efficient and specialised stage. If only the coal export trade would revive—and there are hopes that it will when the Five Counties Marketing Scheme is in full operation—there should be a big inrush of orders to the wagon-building shops, which at present have very little work in hand.

Business in Special Steels.

A section of Sheffield and district industry which gives great promise of development and prosperity is that devoted to the production of high-grade steels. Engineers continue to be more and more exacting in their requirements, but the research workers in the city, both at the Applied Science Department of the University and in the various works laboratories are solving the problems put to them in a highly satisfactory manner. In the production of these special quality steels, Sheffield is still supreme, and the firms concerned report that they are well placed for orders, both for home and overseas. The motor and electrical industries are notable buyers, and there is a steadily increasing call for stainless steel for application on a commercial basis. The big stainless steel producing firms in Sheffield are continually receiving inquiries for quotations for steel for use on a large scale in new directions, but unfortunately the initial cost is heavy, and this frightens many engineers, who would like to make use of this new and, of late, greatly improved material. A considerable amount of work is being done locally in aeroplane steels.

Plate and Cutlery.

Business in the plate and cutlery trades continues to be very irregular. The popular demand at present seems to be for the cheaper quality of goods, and large quantities of stainless steel knives are being dispatched. Counter business for really good hollow-ware and cutlery is not satisfactory, and if it were not for several large contracts for shipping companies, hotels and restaurants, trade would be exceptionally quiet for this period of the year. As there is not enough work to go round, competition among makers is very keen, and, on the whole, the prices obtained are not satisfactory. There is a comparatively poor call for pen and pocket knives and scissors, but the output of steel for safety razor blades, and also of the blades themselves, continues to develop, and a large volume of business is being placed from abroad. Although it is denied that the Army Council has yet definitely placed the contract for safety razor blades for the Army, it is rumoured on good authority that this contract will again be given to an American firm, and it is stated that there is a disparity of over 20 per cent. between the price quoted by this firm and the lowest quoted from Sheffield.

A Sheffield Tram Contract.

A few weeks ago I referred to the placing of a contract for twenty-five tramcar bodies for Sheffield Corporation with W. and E. Hill, Ltd., South Shields, whose quotation was several hundred pounds per car below that of a Sheffield firm. Mr. Edmund Hill, the managing director, denies a statement attributed to him in a London daily paper that his firm had accepted the contract at a loss in order to establish a new industry in South Shields. "On the contrary," he states, "we are perfectly satisfied with the price and conditions under which our firm has secured the work. The contract will be put in hand in a few days' time, and we have expert men to do the work. The standard and quality of it will be equal to what is required of us. It is quite true that we have not built tramcars before, but we shall deliver the goods up to the fullest requirements. What is true is that it is the beginning of a new industry. When it is considered that there are only fourteen or fifteen builders of this character in the whole of the United Kingdom, it would seem to us that there is reasonable hope for a new firm here, particularly as there is none in the North of England at all."

Shipyard Orders.

Cochrane and Sons, Ltd., of the Ouse Shipbuilding Yard, at Selby, have received an order for ten trawlers and one drifter. These vessels will keep the employees at work for the greater part of the year.

Reservoir Work.

It was reported at the last meeting of the Bradford Corporation Water Committee that satisfactory progress has been made in connection with the Scar House reservoir works on which 723 employees are engaged. The filtration works being carried out at Chellow Heights and Bingley will shortly be completed and brought into commission.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Industrial Outlook.

TRADE development in the North of England, which promised well at the beginning of the year, has been a very slow process during recent weeks. A slight improvement, however, is noticeable in the general situation of the iron and steel trades. With inquiries slowly expanding and continental markets inclined to stiffen, the outlook is brightening, but an early quickening of market activity is essential to keep plant well employed. Threatened labour troubles in Central Europe are attracting the close attention of iron and steel manufacturers, as well as colliery owners, for cessation of operations in any of those industries on the Continent would, undoubtedly, speedily influence the position in this district. There seems promise of gradual expansion of home trade, and signs are no longer altogether lacking of some little change for the better in overseas business. Work in the shipyards is still proceeding satisfactorily and expeditiously, but, unfortunately, there is no present influx of new work to take the place of the vessels which are being turned out so rapidly. Many builders have work in hand to ensure active conditions for some time ahead, and there is hope that the tide will turn ere long and save the situation for the closing months of the year. The output so far this year has been greatly in excess of the influx of new work, but all the firms are making strenuous efforts to book more orders, and very low prices are being quoted. Although they have to face a very difficult situation, they show no disposition to slacken their efforts to secure work, and it is probable that at least a few orders will be forthcoming to assist them and their workmen.

Cleveland Iron Trade.

Conditions in the Cleveland pig iron trade show little improvement, but slight movements in the right direction are rather encouraging. Inquiries for one or two descriptions of material are on a better scale, but actual sales keep within narrow limits. Still, with stocks low, and makers fairly well sold for some time ahead, the fixed market rates that have ruled for some weeks past are well maintained. Output is promptly taken up, chiefly for use at local works. Moderate parcels are going to Scotland, but shipments to foreign destinations are still light. No. 1 Cleveland foundry iron is 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; and No. 4 forge, 64s. 6d.

Hematite Pig Iron.

There is little change in the position of the East Coast hematite pig iron trade. Prices do not promise to advance to profitable figures in the near future, but the tendency is upward as a result of continued home and continental buying. Supply is still very ample, output being excessive, so that the already fairly large stocks continue to be slightly added to. Business passing is almost entirely in iron manufactured to analysis to suit customers' particular needs, but recognised market rates are still based on the quotation for mixed numbers, which remains in the neighbourhood of 70s. per ton.

Ironmaking Materials.

Business rules on very quiet lines in the foreign ore trade, but merchants adhere firmly to recent prices. Best Rubio ore is 22s. 6d. per ton c.i.f. Tees. Negotiations for the settlement of the strike of ore miners in Sweden are to be resumed this month, but if terms are agreed upon some little time must elapse before extensive imports are once more unloaded in this area. To conserve, to some extent, their stocks for steel works, consumers of Swedish ore in this area are making more extensive use of Cleveland ironstone at blast-furnaces.

Manufactured Iron and Steel.

The manufactured iron and steel trade is without any new features of moment. Many firms have sufficient contracts arranged to keep them busy over the next three or four months, but others are less favourably placed, and indeed producers of certain descriptions of material are rather urgently in need of orders. Prices are unchanged.

Iron and Steel Imports.

Imports of iron and steel continue to dwindle to the benefit of home trade. Statistics presented at this week's meeting of the Tees Conservancy Commission showed that during the six months ended April, the imports to the Tees from continental countries reached 112,938 tons, as compared with 208,246 tons in the corresponding months of 1926–27, and 37,700 tons in the pre-war period of 1913–14. Pig iron imported during the last six months totalled only 4100 tons, as against 74,876 tons in 1926–27, and 106 tons in 1913–14. Crude sheet bars, billets, slabs, blooms, &c., brought into the river amounted to 88,107 tons, as compared with 103,818 tons in 1926–27 and 24,134 tons in 1913–14, while the imports of plates, bars, angles, rails, joists, &c., reached 20,725 tons, as against 29,552 tons and 13,460 tons respectively.

The Coal Trade.

Coal trade prospects for the next few weeks are a little uncertain. Collieries—and they are perhaps not many—which are prepared to take a risk and sell ahead, have orders to go on with, and thus more or less assure themselves of avoiding idle days, but there are others—the majority—which rely on prompt business, and if it does not come up to expectations, working time is lost. The general tone of the market is not so active as it was in April, and fitters are looking round with more eagerness for trade. The increase in the price of coal in German uncontested areas to the extent of 1s. to 2s. a ton to meet the advance in miners' wages is not without interest to this district, although it is not likely that the price of Westphalian coal will be raised in the coastal districts where British coal is now a formidable competitor. At the same time the higher price for fuel in Germany is causing much concern among industrial undertakings, and the result may be a better demand for coal from this neighbourhood. At any rate, merchants are alert to the possibilities and are prospecting accordingly. In Northumberland minimum prices are adhered to and are likely to be maintained, as the industry is unable to face more losses. The proceeds and costs in March, which would determine wages in May, provide for only 5·66 per cent. addition to basic wages, as compared with 37·42 per cent. in April, a drop of no less than 31·76 per cent. The revised minimum percentage is 40, and it will continue to be paid in the present month, leaving the owners with a deficiency to make up of 34·34 per cent. Best Northumberland steams are quoted at 13s. 6d., with second qualities at 12s. Gas coal prices in Durham are not definitely fixed, as are steam values, but they are kept at a steady level by the expedient of laying pits idle when there is not sufficient trade at the prevailing figures. Best gas coals command from 15s. to 15s. 3d., and seconds 13s. 6d. to 14s. There is no particular revival in the demand for coking coals, and bunkers are fully steady for the higher classes. There is a brisk demand for gas coke for shipment abroad from June onwards, and merchants hesitate to offer, as makers indicate very firm prices, and the tendency of the market is towards a rapid advance in values. For prompt the price is easy at 19s. 6d., but for over the year 20s. is generally indicated. Patent oven cokes are quiet at 17s. to 17s. 6d. for prompt for good brands, but forward the tendency is towards advancing prices. Beehive coke is quiet at 24s. to 27s.

Inquiries from America for Welded Pipes.

Inquiries from America for substantial requirements in welded steel pipes, said to exceed 100,000 tons, have reached Teesside, and some hope is held out of business materialising.

SCOTLAND.

(From our own Correspondent.)

Steel.

ON the whole, the market for steel shows little change, and the works, as a rule, are engaged well below capacity. Producers, however, gain some satisfaction from the fact that German prices are stiffening, and are hopeful that the process will continue. Meanwhile, makers of shipbuilding materials note a falling off in demand for plates and sections owing to a decrease in fresh shipbuilding contracts. A steady shipbuilding demand is almost a necessity in this district, and any fluctuation is quickly reflected in the position at the steelworks. Structural steel is comparatively slow at present, but the situation has been relieved to some extent by the placing of some fair orders for steel rails. Prices are unchanged.

Steel Sheets.

A somewhat better demand has been experienced for black sheets, but neither the home nor the export turnover is yet up to the normal for this season of the year. Galvanised corrugated sheets are quoted £13 5s. per ton home and £13 per ton export.

Tubes.

The outlook in the tube trade is improving. Both light and heavy descriptions are busier, and prospects are encouraging.

Iron.

The bar iron works are poorly engaged, and the position in the re-rolled steel department is little, if any, better. Home orders are confined to small lots, and overseas business is extremely limited. Home prices are unchanged, but a good export order for either iron or re-rolled steel might be placed somewhat below the current quotations, which are £9 15s. per ton bar iron and £7 re-rolled steel.

Scrap.

A somewhat better demand for iron and steel scrap is reported, and prices have firmed to 65s. per ton for heavy steel and cast iron scrap.

Pig Iron.

Sales of pig iron to home consumers are limited, and business with overseas customers is extremely small. Prices are upheld by the enhanced costs of production. During the past week a cargo of 1000 tons of pig iron arrived at Glasgow from India. Shipments of Scottish pig iron during the week totalled 1020 tons.

Exports and Imports.

Over 12,000 tons of iron ore were discharged at Glasgow during the past week, and arrivals included 1500 tons of iron and steel products. Iron and steel shipments only totalled 2500 tons.

Coal.

Despite the reduction in output, now estimated at 100,000 tons per week, many descriptions of fuel are still in ample supply. Foreign demands are very restricted, and in this connection Scandinavian markets are especially disappointing. Despite the scarcity of orders the collieries are evidently not prepared to discount the market in order to stimulate business. Export transactions, therefore, are confined to small lots for immediate consumption. Home demands are declining. Lanarkshire splints and ells and Fifeshire steams are comparatively well placed, particularly the first named, but practically all other descriptions could do with a considerable increase in turnover. Continental competition continues keen, and prospects

of a change in this direction are not bright. Aggregate shipments during the past week amounted to 247,161 tons, against 239,544 tons in the preceding week, and 274,168 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE is nothing very satisfactory to report about the general conditions prevailing in the steam coal section of the industry of this district. The current inquiry for supplies appears to have slackened off to some extent, and the demand for coals for delivery over a period displays no special feature. The Great Northern Railway of Ireland is in the market for about 40,000 tons of locomotive coals for delivery over twelve months, but although South Wales has supplied this undertaking in the past with a fair proportion of its coal requirements, it is by no means certain that the order on this occasion will come to this district, as without doubt the company is seeking prices from other areas. Apart from the fact that the foreign demand for coals is quiet, it is very clear that the quantity of tonnage which is available for employment is reduced. Many merchants are finding it very difficult to secure the tonnage they require for the orders which they already hold, and it is not surprising that the outward freight market should take a turn for the better, though this remark does not apply to the coasting trade. Up to the middle of last week the loading position at South Wales ports was not at all bad, but on Saturday the situation was very much worse than has been the case for a long time past. The official report then showed that no less than fifty-eight tipping appliances were idle at the various docks. Even arrivals of steamers over the week-end did not change the position to the extent that was hoped for, as on Monday morning there were still thirty-seven appliances out of operation.

Colliery Amalgamations.

For the past week or two rumours have been current of proposed amalgamation of interests in the anthracite section of the South Wales coalfield, but no official information has been forthcoming, except of a negative character. In the steam coal area the official announcement is made that an amalgamation was effected at Cardiff on Monday of the Bwllfa and Merthyr Dare Steam Collieries (1891), Ltd., and the Cwmaman Coal Company, Ltd. The new undertaking will be known as the Bwllfa and Cwmaman Collieries, Ltd., and the sale of the company's coal will be in the hands of Mr. H. H. Merrett, managing director of Gueret, Llewellyn and Merrett, Ltd. Under the conditions of amalgamation the shareholders of the Cwmaman Company receive shares of the Bwllfa company and the joint concern will work an area of about 5000 acres in extent. There are definite advantages in this amalgamation of interests, as the properties are adjoining and the coals are similar, being of the dry type. The directorate of the Cwmaman company retires and there will be material economies effected in administration charges and working costs. It is estimated that the properties have about 100,000,000 tons of workable coals. There are five pits and three drifts, capable of an output of 1¼ million tons of coal per annum.

Improved Coal Inquiry Expected.

As the result of the strike of the inland navigation sailors on the Rhine and the consequent dislocation which this is causing to the German coal export trade, the feeling prevails that the demand for coals from this country will be favourably affected. Reports are already in circulation that continental inquiries are now definitely on this market for supplies of steam coal, but there is so far no confirmation of those reports. The probability is that North Country coals will first feel the effects of the stoppage of the German coal exports, but in any event coalowners and exporters are very closely watching the position. The strike of the German inland navigation sailors is for increased pay.

Tin-plate Trouble.

Just at a time when the tin-plate trade is emerging from a most depressing period and the outlook is brighter, there has been an unfortunate development as the result of which nearly 2000 men are idle. Early last week 300 men employed in the finishing department at the Grovesend group of tin-plate works near Swansea struck work in sympathy with a tin-house workman at the Gorseinon works, who had been summarily dismissed under circumstances which have not been made public. His fellow-workmen at the tin-house objected to the dismissal, whereupon the management gave him and two other workmen their usual twenty-eight days' notice. The other employees strongly resented this action and contended that the matter should have been submitted to the works committee. They asked for the notices to be withdrawn, but this the management refused to do. The result was that the other tin-house men at the Gorseinon works came out in sympathy, and on Wednesday they were supported by those employed at the Grovesend company's works at Mardy and Grovesend. The outcome of this action was that the management was compelled to close down the twenty-three mills connected with these three finishing departments, and there are now nearly 2000 men idle. Under the rules of the constitution governing the tin-plate industry, no negotiations can take place unless the strikers first return to work. The men have been instructed to resume work so that negotiations can be opened and the matter investigated, but the tin-house men have only reaffirmed their decision not to comply with this direction unless the management also admits that it has violated the constitution.

South Wales Trade.

Official returns issued by the Great Western Railway Company relating to the trade at the docks under its control in this district show that the figures for the four weeks ended April 15th last were not as good as those for the preceding four weeks. The total of imports and exports came to 2,540,438 tons, made up of 370,460 tons of imports and 2,169,978 tons of exports, which compared with an aggregate of 2,917,843 tons, made up of 358,770 tons of imports and 2,559,075 tons of exports for the four weeks ended March 18th last. Taking the whole of this year to April 15th last the total of imports and exports comes to 10,032,245 tons, which compares with 11,409,661 tons for the corresponding period of last year.

Current Business.

Operations have been on a very quiet scale, and there is very little life in the steam coal market. Most of the leading colliery undertakings have fairly good order books, but tonnage is scarce and consequently their immediate position is not as satisfactory as would otherwise be the case. At the same time quotations practically all round are upheld. So far, nothing definite has been revealed regarding the fixing of minima prices in respect of sized coals, though the matter has been under consideration. Dissatisfaction has prevailed for some time on the part of the trimmers and tippers concerning the present working arrangements at the docks and the operation of what is known as the split shift system. At their recent annual meeting the Cardiff, Penarth and Barry coal trimmers instructed their officials to press for an alteration, and there was to be a national conference of representatives of coal trimmers and tippers of the United Kingdom in London on Thursday of this week to consider the question of working hours and the position in South Wales.

Catalogues.

J. A. MAFFEI A.-G., Munich, Germany.—"Some Opinions on Maffei Locomotives."

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., 170, Piccadilly, W. 1.—Pneumatic tool catalogue No. 44.

THE BRITISH OXYGEN COMPANY, Ltd., Angel-road, N. 18.—Two publications dealing with universal oxygen cutting machines.

JAMES ARCHDALE AND CO., Ltd., Ledsam-street, Birmingham.—List A1 of drilling and milling machines for the automotive industries.

BERNARD HOLLAND AND CO., Ltd., 17, Victoria-street, S.W. 1.—A catalogue on rotary air compressors and vacuum pumps for all services.

BROOKHURST SWITCHGEAR, Ltd., Northgate Works, Chester.—Booklet dealing with the question of electrical control of printing machinery.

WRIGHT, ANDERSON AND CO., Ltd., Gateshead-on-Tyne.—A catalogue illustrating a number of steel-framed structures erected by the firm.

REAVELL AND CO., Ltd., Ranelagh Works, Ipswich.—Pamphlet No. 162, on "Reavell" compressed air deck machinery for oil-engined ships.

THE OSGOOD COMPANY, Marion, Ohio, U.S.A.—A brochure dealing in detail with the various types of Osgood petrol or electric drive excavators.

THE CASSEL CYANIDE COMPANY, Ltd., 19, St. Vincent-place, Glasgow.—A treatise on case hardening and the heat treatment of steel by sodium cyanide.

JOHN PICKLES AND SON (ENGINEERS), Ltd., Hebden Bridge.—A catalogue of fifty pages giving the chief features of some of the firm's woodworking machinery.

THE DOWSON AND MASON GAS PLANT COMPANY, Ltd., Levenshulme, Manchester.—A leaflet, giving particulars of the "Hawke" visible petrol measure.

DRAYTON REGULATOR AND INSTRUMENT COMPANY, Ltd., West Drayton, Middlesex.—A leaflet dealing with pressure and temperature operated electric switches.

FREDK. BRABY AND CO., Ltd., Petershill-road, Glasgow.—List No. BB55 on steel barrows for all classes of work; also brochure No. 28 on the firm's general products.

THE BRITISH REMA MANUFACTURING COMPANY, Ltd., High-road Well, Halifax.—Catalogue describing the British Rema ring mill and vacuum system applied to pulverising coal.

STURTEVANT ENGINEERING COMPANY, Ltd., 147, Queen Victoria-street, E.C. 4.—Catalogue No. 1054 on steel plate fans illustrating the use of various types in different branches of industry.

EDGAR ALLEN AND CO., Ltd., Imperial Works, Sheffield.—The fifth edition of the booklet "Stag High-speed Steels," and further particulars of drilling with the J. W. Barnes patented floating drill chuck.

HOPKINSONS LTD., Britannia Works, Huddersfield.—List No. 2340, giving particulars of "Duplus," "Radus," and "Micros" steam traps. Also list No. 2240 of the "Duo" patented feed-water regulator, giving particulars of its installation and advantages gained thereby.

CONTRACTS.

WAILES DOVE BITUMASTIC, Ltd., asks us to state that its protective coatings have been applied to the new Singapore Floating Dock.

THE EAST FERRY-ROAD ENGINEERING WORKS COMPANY, Ltd., of Millwall, London, E. 14, has received an order from the Port of London Authority for twenty portable hydraulic luffing cranes for use in the various London docks. These cranes are of 30 cwt. capacity and a maximum radius of 65ft., and are of the portal type.

THE ELECTRIC FURNACE COMPANY, Ltd., 17, Victoria-street, London, S.W. 1, has recently received an order to supply to French steel makers an Ajax-Northrup high-frequency furnace for melting 1 ton of steel per hour, a capacity which is four times larger than that of any high-frequency furnace yet constructed. The same company has also received orders (*a*) for several Ajax-Wyatt furnaces for brass melting for France, including the installation for the Renault motor works; (*b*) for Ajax-Northrup high-frequency furnaces for Birmingham, Sheffield, London and Braintree; (*c*) for Ajax-Wyatt furnaces for Birmingham brass manufacturers; (*d*) for a pair of furnaces of 240-kW capacity for the heat treatment of aluminium alloys for Coventry, &c. The company now has forty-five furnaces in construction for delivery in England, Scotland, France, Germany, Spain, New Zealand, and other countries.

LAUNCHES AND TRIAL TRIPS.

BRITTA, twin-screw motor tanker; built by Burmeister and Wain, Ltd., to the order of A/S Helsingfors Jernskibs-og Maskinbyggeri; dimensions, length 405ft., breadth 54ft. 6in., depth 32ft. 3in.; to carry 9100 tons. Engines, two sets of six-cylinder, four-cycle, single-acting Diesel; trial trip, March 30th.

SUD ATLANTICO, twin-screw motor ship; built by Burmeister and Wain, Ltd., to the order of A/S Linea Sud Americana; dimensions, length 380ft., breadth 53ft. 6in., depth 38ft.; to carry gross tonnage 4640. Engines, two six-cylinder, four-cycle, single-acting, long-stroke Diesel; on the speed trial 13·68 knots were attained, the main engines developing 3866 I.H.P. at 110·25 revolutions per minute; trial trip, April 2nd.

ATHENE, single-screw motor tanker; built by Sir W. G. Armstrong, Whitworth and Co., Ltd., to the order of A./S. Varild, Oslo; dimensions, 359ft. by 53ft. 3in. by 28ft.; to carry 6530 tons on a mean draught of 23ft. Engines, one single-acting, two-cycle, six-cylinder, direct reversing Diesel engine; launch, April 24th.

KING STEPHEN, motor cargo vessel; built by Harland and Wolff, Ltd., to the order of King Line, Ltd.; dimensions, 400ft. by 54ft. 6in. by 34ft. 8in.; gross tonnage 5280. Engines, one Harland-B. and W. six-cylinder, four-cycle, single-acting Diesel engine; constructed by the builders; launch, April 24th.

NEWBRUNDOC, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Paterson Steam Ships, Ltd., Fort William, Ontario, Canada; dimensions, 253ft. long. Engines, inverted marine type with three cranks; constructed by the builders; trial trip, April 24th.

NIEMEN, steel screw steamer; built by Craig, Taylor and Co., Ltd., Stockton-on-Tees, to the order of the Polish Ministry of Industry and Trade, Warsaw, Poland; dimensions, 337ft. by 48ft. by 24ft. 3in. Engines, triple-expansion, 23½in., 39in., 64in. by 42in. stroke, pressure 180 lb. per square inch; constructed by North-Eastern Marine Engineering Company, Ltd.; a speed of 12 knots was maintained on trial trip, April 24th.

HOOIBERG, shallow-draught oil tanker; built by Harland and Wolff, Ltd., to the order of Lago Shipping Company, Ltd.; dimensions, 315ft. by 50ft.; 2360 gross tonnage. Engines, twin-screw triple-expansion, pressure 180 lb. per square inch; trial trip, April 25th.

ELSA, oil tanker; built by Barclay, Curle and Co., Ltd., to the order of Harry Borthen and Co., of Norway; dimensions, 400ft. by 52ft. 6in. by 30ft. 6in.; to carry 8160 tons deadweight on a draught of 25ft. 1½in. Engines, three-cylinder set of Barclay-Curle-Doxford opposed-piston airless injection oil engines; constructed by the builders; a speed of 11·57 knots was attained on trial trip, April 26th.

HALLANGER, twin-screw motor tanker; built by Nederlandsche Scheepsbouw Maatschappij, to the order of Norwegian owners; dimensions, 474ft. 5in. by 64ft. 6in. by 36ft. 6in. Engines, two single-acting, four-cycle Werkspoor Diesel motors of 1350 B.H.P. each; trial trip, April 26th.

OLTENIA, oil tank steamship; built by Sir W. G. Armstrong, Whitworth and Co., Ltd. to the order of Steaua Romana Societate Anonima pentru Industria Petroleului, Bucharest; dimensions, 436ft. by 55ft.; to carry 9400 tons deadweight on about 25ft. 6in. draught. Engines, single-screw quadruple steam engine, pressure 220 lb. per square inch; a speed of 12 knots was attained on trial trip, recently.

CARONI, twin-screw oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of Venezuela Gulf Oil Company; launch, May 3rd.

HIGHLAND MONARCH, motor vessel; built by Harland and Wolff, Ltd., to the order of H. and W. Nelson, Ltd.; dimensions, length B.P. 520ft., breadth 69ft., depth 35ft. 9in.; to carry gross tonnage 14,450. Engines, two eight-cylinder, double-acting, four-cycle; launch, May 3rd.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, May 7th, Sir James Crichton-Browne, Vice-President, in the chair. Sir J. J. Thomson was elected Honorary Professor of Natural Philosophy and Sir Ernest Rutherford was elected Professor of Natural Philosophy. Miss Ingram, Mrs. Paul and Cuthbert Johnson were elected members.

THE INSTITUTION OF MINING AND METALLURGY.—On Tuesday last Mr. Robert E. Palmer presided at the annual dinner of the Institution of Mining and Metallurgy, at the Hotel Cecil. The toast of "The Institution" was proposed by Sir Francis Ogilvie, chairman of the Geological Survey Board, who outlined the influence which the Institution had exercised upon the education of mining engineers. The President, in the course of his response, announced that the Gold Medal of the Institution had been awarded to Sir Alfred Mond in recognition of his scientific and industrial services in the development of the mineral resources of the Empire. The toast of "The Guests" was proposed by the President-Elect, Professor S. J. Truscott, and acknowledged by Sir William Larke, director of the National Federation of Iron and Steel Manufacturers, and Mr. George S. Rice, of the United States Bureau of Mines. Sir William said that this country was as well equipped scientifically and technically as any nation in the world, but a national industrial sense was needed to exploit commercially its good qualities.

SHIPBUILDING—FROM SMACK TO FRIGATE, FROM CUTTER TO DESTROYER.—We have recently received from J. Samuel White and Co., Ltd., of Cowes, a handsomely printed and illustrated book bearing the above title, in which the history of the firm is traced from the year 1764 up to the present time. "White of Cowes," has become such a familiar phrase in shipbuilding circles that there are few who would associate the firm with another locality. We learn, however, that Mr. John White, who was the great great grandfather of J. Samuel White, the founder of the firm, was an established shipbuilder at Broadstairs in the Isle of Thanet in the year 1764. A draught book of that year, which was prepared by Mr. J. White, shows that a very wide range of craft, embracing deep sea fishing vessels, fast coasters, revenue cutters, and other King's ships up to frigates, was constructed by the firm. It was Mr. Thomas White who, towards the end of the eighteenth century moved, along with his family, to Cowes and took over Nye's Yard, at which naval ships had been constructed since the year 1696. Larger ships and yachts were built by Whites, at Cowes, and in 1840 the Medina dry dock was constructed and was soon followed by two smaller graving docks. The subsequent development of ship repairing and shipbuilding at Cowes is described in a most interesting way, covering the period from 1850 up to the present. Some excellent illustrations are given of the naval ships, mercantile vessels, and lifeboats built by the firm. The war activities of Whites were notable, and we read that the firm's contribution of new ships to the Fleet included twenty-two destroyers, eleven patrol vessels, and three submarines, besides aircraft. More recently oil engines have been built, foreign destroyers reconditioned, and a large paddle steamer for passenger service on the Thames Estuary was completed at Cowes. The narrative closes with the announcement that the firm has now under construction three flotilla leaders for the Argentine Government, which will embody the most recent practice as regards speed and armament. The book has been published on behalf of the firm by the Albion Publishing Company, Ltd., of London.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/- to 21/-
(1) Spanish	19/- to 21/-
(1) N. African	19/- to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 14 0	—
No. 1 Foundry	3 15 0 to 3 16 0	—
No. 3 Foundry	3 10 0 to 3 11 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 10 0	3 10 0
No. 1	3 10 6	3 10 6
Cleveland—		
No. 1	3 8 6	3 8 6
Silicious Iron	3 8 6	3 8 6
No. 3 G.M.B.	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 6	3 4 6
Mottled	3 4 0	3 4 0
White	3 4 0	3 4 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 2 6	—
(3) Northampton—		
Foundry No. 3	2 18 0 to 2 19 0	—
Forge	2 13 6	—
(3) Derbyshire—		
No. 3 Foundry	3 3 6 to 3 4 6	—
Forge	2 19 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 3 6	—
No. 4 Forge	3 1 0	—
Basic	3 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 2 0 (a) / 4 5 0 (b) / 4 8 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 17 6 to 9 0 0	—
Gas Tube Strip	11 0 0	—

STEEL. (d)

	(6) Home. £ s. d	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ¼in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 12 6	8 10 0
Sheets (Gal. Cor. 24 B.G.)	13 5 0	13 0 0

STEEL (*continued*).

	Home. £ s. d	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 12 6	—
Soft Billets	6 15 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	7 10 0 to 10 0 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
,, (Small Round)	7 10 0	—
Hoops (Baling)	10 5 0	10 0 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6	—
,, (Lancs. Boiler)	10 0 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Hard Basic	7 2 6 to 7 12 6	—
Intermediate Basic	7 0 0	—
Soft Basic	6 5 0	—
Hoops	9 10 0 to 10 10 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars	7 5 0 to 8 0 0	—
Billets and Sheet Bars	5 15 0 to 6 0 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 0 0 to 13 2 6	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	11 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/4½ to 18/7½
Block Tin (cash)	232 0 0
,, (three months)	231 2 6
Copper (cash)	61 8 9
,, (three months)	61 13 9
Spanish Lead (cash)	20 3 9
,, (three months)	20 10 0
Spelter (cash)	26 6 3
,, (three months)	25 18 9
MANCHESTER—	
Copper, Best Selected Ingots	65 15 0
,, Electrolytic	67 5 0
,, Strong Sheets	92 0 0
,, Tubes (Basis Price), lb.	0 1 1
Brass Tubes (Basis Price), lb.	0 0 11½
,, Condenser, lb.	0 1 2
Lead, English	22 0 0
,, Foreign	20 15 0
Spelter	26 10 0
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/7½ per lb.	
Ferro Tungsten	1/3 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 2 6	7/-
,, ,, 8 p.c. to 10 p.c. ,,	£22 0 0	6/-
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£35 0 0	12/-
,, ,, ,, 1 p.c. carbon	£40 10 0	15/-
,, ,, ,, 0·70 p.c. carbon	£46 10 0	17/-
,, ,, ,, carbon free	1/2 per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (per ton)	£13 10 0 for home	
	£13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	14/3 per lb.	
,, Molybdenum	4/6 per lb.	
,, Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.
(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/9
,, ,, Ell	14/6
,, ,, Splint	16/3 to 17/-
,, ,, Trebles	13/3
,, ,, Doubles	12/3
,, ,, Singles	11/3
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/-
,, ,, Jewel	15/6
,, ,, Trebles	12/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	11/- to 13/-
Screened Navigation	18/-
Trebles	12/3 to 12/9
Doubles	12/3 to 12/6
Singles	11/3
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/6 to 12/-
Secondary Steam	11/3
Trebles	12/3
Doubles	12/-
Singles	11/3

ENGLAND.

(8) N.W. COAST—	
Steams	24/- to 25/-
Household	37/6 to 50/-
Coke	22/6 to 23/6
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	11/9 to 12/-
Steam Smalls	9/- to 9/6
Unscreened	11/9 to 12/-
Household	21/- to 27/-
DURHAM—	
Best Gas	15/-
Second	13/3 to 13/9
Household	21/- to 27/-
Foundry Coke	17/6 to 18/-

SHEFFIELD—	Inland.
Best Hand-picked Branch	27/6 to 29/6 —
Derbyshire Best Bright House	20/6 to 21/6 —
Best House Coal	19/- to 20/6 —
Screened House Coal	16/- to 17/6 —
,, ,, Nuts	15/- to 16/- —
Yorkshire Hards	15/- to 16/- —
Derbyshire Hards	15/- to 16/- —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	6/- to 7/- —
Smalls	3/- to 4/6 —
Blast-furnace Coke (Inland)	13/- at ovens —
Furnace and Foundry Coke (Export), f.o.b.	16/9 to 17/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	19/3 to 19/9
Second Smokeless Large	18/6 to 19/-
Best Dry Large	18/- to 18/6
Ordinary Dry Large	17/3 to 18/-
Best Black Vein Large	17/3 to 17/9
Western Valley Large	16/9 to 17/3
Best Eastern Valley Large	16/6 to 17/3
Ordinary Eastern Valley Large	16/3 to 16/6
Best Steam Smalls	12/6 to 13/-
Ordinary Smalls	11/- to 12/6
Washed Nuts	18/- to 21/-
No. 3 Rhondda Large	19/6 to 20/-
,, ,, Smalls	14/- to 14/9
No. 2 ,, Large	16/- to 16/3
,, ,, Through	14/6 to 15/6
,, ,, Smalls	12/6 to 13/6
Foundry Coke (export)	30/- to 37/6
Furnace Coke (export)	27/6 to 30/-
Patent Fuel	21/6 to 22/6
Pitwood (ex ship)	27/3 to 27/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	32/- to 34/-
Seconds	24/6 to 27/6
Red Vein	20/6 to 27/-
Machine-made Cobbles	40/- to 42/6
Nuts	37/6 to 42/6
Beans	23/- to 27/-
Peas	17/9 to 19/-
Breaker Duff	8/- to 8/6
Rubbly Culm	10/- to 10/6
Steam Coals:	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	10/- to 12/-
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our own Correspondent in Paris.)

Stabilisation.

THE events of the past week have imparted a more general feeling of security in the future of the iron, steel and engineering trades. The work of financial readjustment, which has given such excellent results during the past year, will proceed under more satisfactory conditions even than before. It is believed that the franc will be officially stabilised in the course of the next few months, and the present better tone of trade is due to the expectation that the placing of the franc on a definite gold basis will mark the beginning of an industrial recovery. Manufacturers are able to look hopefully to the future, because the trade situation generally has undergone some improvement, mainly because customers who had held aloof pending the general elections are now giving out orders. There is more activity at the mills and forges and even in the engineering shops, and prices all round are hardening. While on the home market prices are firmly upheld by the *comptoirs* quotations for export are advancing. The hardening values are due less to an increased demand than to the fact that higher charges are raising production costs, and that is a matter which is likely to cause some deception in the future, since there can be no permanent revival of activity within an undue inflation of prices. In many cases the coefficient of 5 has been exceeded, and if the purchasing value of the gold franc should fall still further, it is obvious that the situation will become a difficult one for manufacturers. They are still able to do foreign business by accepting relatively low prices on the strength of the higher values they impose on the home market, but if they find that those values check the home demand producers will be far less able to carry on competition for foreign business. That is what is happening to a certain extent at the present moment.

Coal.

The production at the French collieries is diminishing, and the number of miners employed is decreasing, although it is affirmed that this affects only the foreign miners, a large number of whom are returning to their respective countries. Nevertheless, the miners are growing uneasy, and they have had several interviews with Government representatives in the hope of finding some solution of the difficulty, but as every possible remedy has been applied, it is obvious that the Government can do nothing further to help them. There can be no question of advancing wages, which can only have the effect of increasing the cost of coal. The experience in Germany shows sufficiently the danger of such a course. The present crisis is due to a continental over-production, and can only be alleviated by an international policy of restricted output. French, Belgian and German coalowners are all in favour of some such arrangement, but no definite programme has yet been put forward, mainly on account of the opposition of British coalowners, who are stated to have resolved to hold aloof from any continental combination. It is obvious that many coal mines which started operations during the strike of British colliers will have to be closed down. In the Loire basin the situation has become particularly serious.

Flying Boats.

The loss of the flying boat "Richard Penhoët" at St. Nazaire is a serious matter for French aviation, which had based considerable hopes upon the performance of this latest development of aero construction. It was intended to forestall the Germans in providing a passenger service across the South Atlantic, and in its design everything had been done to ensure the greatest chance of safe transport. The boat, which was supposed to be capable of weathering any ordinary seas in case of accident, was built with watertight compartments, and was fitted with five engines, two of which could be cut out, and were intended to be used for taking off and for cases of emergency. The position of the engines appears to have caused trouble in the early stages of the trials, and certain modifications had to be carried out until finally the huge machine, probably the largest yet constructed, was declared to be under easy control. The boat was preparing for its official trials and had left the Chantiers de Penhoët at St. Nazaire for a flight, when it was seen to dive suddenly from a low altitude and disappear into the sea. A loud explosion is said to have been heard. The pilot and two mechanics managed to free themselves and were saved, but a passenger was drowned. The survivors could give no explanation as to what had happened to cause the accident.

Used Water Disposal.

The system which consists in facilitating the flow of sewage in sewers with a small incline, by means of the sudden application of a partial vacuum, is giving satisfactory results in the town of Sables-d'Olonne, and experiments are now being carried out with the same system for the collection of household refuse. Sables-d'Olonne is a seaside town built on a flat site, and it is practically impossible to give a sufficient gradient to the sewers to insure proper collection by gravitation. The sewers therefore terminate in an exhausting chamber that can be closed by a valve, and the chamber communicates with the collectors conveying the sewers to the works, where it is pumped into the sea. The works have also an installation of vacuum pumps which, from time to time, create a partial vacuum in the collectors, when the valve in the exhausting chamber is suddenly opened, which in turn exhausts all sediment and solid matter into the collectors. In dealing with household refuse, the difficulty lies in preventing anything that may cause a positive obstruction from entering the pipes. In the experiments now being carried out two methods are employed in order to see which will give the better results. One is to pass the rubbish through screens so as to reject what cannot be conveniently dealt with and the other reduces the whole in crushing machines.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

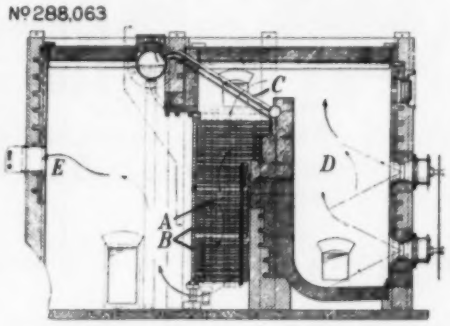
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

288,063. June 21st, 1927.—STEAM GENERATORS, *Babcock and Wilcox, Ltd., Farringdon-street, London, E.C.* 4.

This is what might be described as a compound boiler. There is a series of tubes A connected together by headers B, through which the feed water is circulated by means of a pump, in series.

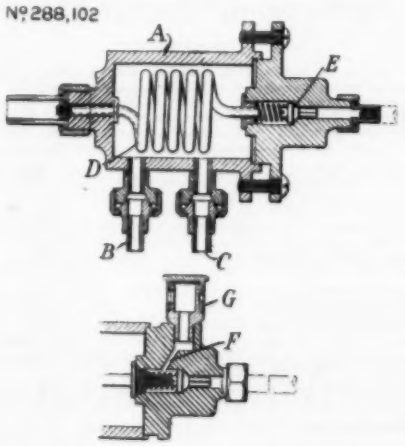


The mixture of water and steam provided by this section is delivered to another set of tubes C, where it flows in parallel on account of natural circulation. The headers B are so arranged as to form a flue through which the products of combustion flow downwards from the furnace D to the outlet E.—*April 5th*, 1928.

INTERNAL COMBUSTION ENGINES.

288,102. October 19th, 1927.—THE HUMIDIFICATION OF THE COMBUSTIBLE CHARGE OF INTERNAL COMBUSTION ENGINES, H. Mills, 2, Lake View, Shore, Littleborough, Lancs.

In this system the heat of the exhaust gases is used to vaporise, more or less, the water aded to the combustible charge. The

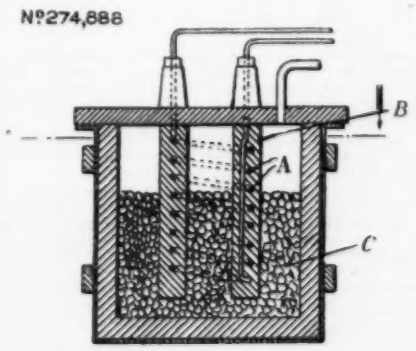


exhaust gases are circulated through a chamber A by means of the branches B and C. Within the chamber there is a coil D through which the water passes, under the control of a non-return valve E. A certain amount of air is also admitted to the heater by the port F, and this amount can be regulated by the device shown at G.—*April 8th*, 1928.

ELECTRICAL APPLIANCES.

274,888. July 21st, 1927.—IMPROVEMENTS IN OR RELATING TO IRONLESS INDUCTION FURNACES OR HEATING APPARATUS, Siemens & Halske Aktien-Gesellschaft, of Berlin-Siemensstadt, Germany.

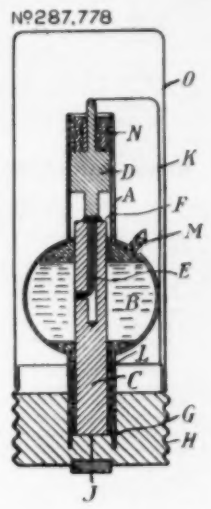
According to this invention the heat produced by induction



in the charge material is generated by a heating coil, which is dipped or inserted into the charge material situated in the interior of the furnace, so that a large part of the external electromagnetic lines of force produced by the heating coil pass through the charge. The coil A is embedded in a refractory hollow cylinder B, so that it dips or is immersed in the charge material C. The eddy currents generated in the charge material C and eventually the hysteresis heats the material contained in the interior of the refractory body B, as well as the material surrounding the refractory coil body.—*March 19th*, 1928.

287,778. August 24th, 1927.—IMPROVEMENTS IN OR RELATING TO CURRENT RECTIFIERS, Lucien Levy, of 66, rue de l'Université, Paris, France.

A rectifier constructed in accordance with this invention consists of a glass tube A with a central bulb portion B containing an aluminium cylinder C and copper oxide cylinder D. The cylinder C is bored axially at E and opens into the central bulb, which is filled with ammonium hydrosulphide, and is provided with a cotton wick. The contact between C and D is therefore constantly maintained in a damp and sulphuretted condition. Owing to the passage of the current during the formation, a coating F of copper sulphide is formed, which,

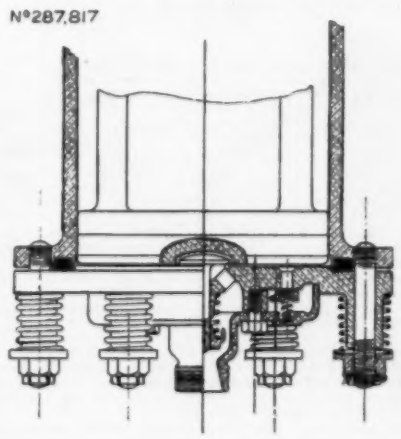


after a certain time has elapsed, mechanically welds the copper to the aluminium. The aluminium cylinder and the glass tube are sealed with wax at the part G and the threaded plug H is provided with a central contact J, which is electrically connected with the aluminium cylinder C, while the external screw is connected to the copper D by the connection K. The valve is made tight by pouring paraffin in at L before filling it with hydrosulphide, which is done through the opening M. The filling is completed by pouring in petroleum jelly, the opening M being finally sealed with a blow pipe. After the formation, paraffin is run in at the point N. An aluminium cap O, secured to the threaded portion H, protects the valve from damage.—*March 29th*, 1928.

PUMPING AND BLOWING MACHINERY.

287,817. December 1st, 1927.—AIR EXHAUSTERS FOR FIRE PUMPS, Merryweather and Sons, Ltd., Greenwich-road, London; J. H. Osborne and A. W. Burford, Villete, Guibal-road, Lee, S.E. 12.

This invention is concerned with reciprocating air pumps used to prime fire pumps. An interceptor is generally provided to

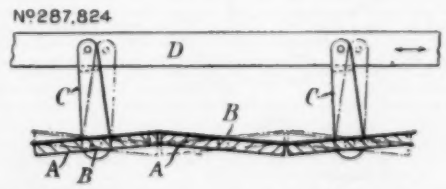


prevent the entry of water into the air pump, but may fail to act, to the detriment of the pump. The inventors consequently arrange springs under the nuts of the cylinder cover bolts, so that the cover may yield to the blow of any water in the cylinder. The drawing is self-explanatory.—*March 29th*, 1928.

MINING MACHINERY.

287,824. December 8th, 1927.—SLUICING AND ORE CONCENTRATING APPARATUS, J. E. Day, 46, Torrington-square, London, W.C. 1.

The inventor aims at improving the classifying effect of a



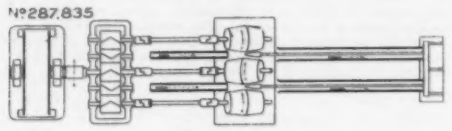
sluice box in washing mineral ores. To this end he provides the box with a false bottom made of a series plates A A, which can rock on trunnions B. The plates are covered with a sheet

of rubber and are gently rocked by means of the levers C C and the connecting bar D.—*March 29th*, 1928.

MACHINE TOOLS AND SHOP APPLIANCES.

287,835. January 9th, 1928.—TUBE ROLLING MILLS, R. Trant, 69, Friedrichstrasse, Mulheim-Ruhr, Germany.

This invention is concerned with mills having inclined conical rolls used for making seamless tubes. It is urged in the specification that much time is lost with the usual arrangement through

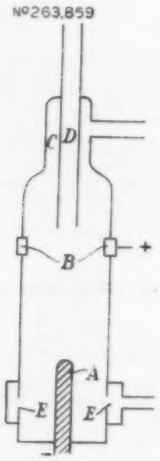


having to wait while the mandrel is extracted from the pierced billet. The inventor consequently provides his mill with three rolls instead of two, and uses the two passes alternately. He claims that the mill requires no more power than a two-roll mill and gives double the output.—*March 29th*, 1928.

MISCELLANEOUS.

263,859. December 30th, 1926.—RECOVERY OF REACTION PRODUCTS FROM GASES TREATED WITH ELECTRIC ARCS, I. G. Farbenindustrie Aktiengesellschaft, of Frankfort-on-Main, Germany.

It has been discovered that, when a single current of a gas or a mixture of gases are treated in electric arc furnaces, the space of which is not entirely filled by the electric discharge, the gases leaving the reaction vessel are not uniform, but contain different quantities of the desired reaction products in different portions of a cross-section of the discharge pipe. The uniform composition of the reaction gases is obtained only after the gases have passed a comparatively long distance, which depends on the shape of the gas conduits, the speed of the gas and various other conditions. According to this invention the discovery is utilised for facilitating the recovery of the reaction products from a single current of a gas or a mixture of gases, treated with electric arcs. For this purpose the inventors arrange in com-



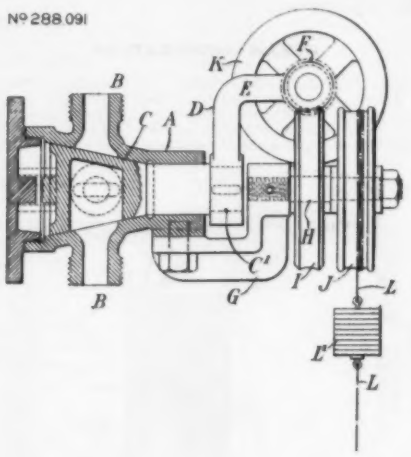
bination with the usual gas conduits or pipes for the reaction gases one or more small outlet tubes or pipes or outlet openings so that they allow a separation of the gas portion rich in reaction products from that low in reaction products. The small outlet pipes may be so arranged that they lead off the gas rich in reaction products or they may serve for the removal of the poor gas leaving the rich gas in the main passage. One example of the invention is shown. An arc is produced between a central cathode A and an annular anode B. The gas conduit C is provided, near where the gases enter the conduit, with a small outlet pipe or tube D arranged concentrically therein. Methane is introduced into the furnace in a direction tangential to the furnace by nozzles E. The resulting gases, when led away in the manner as hitherto in use by the pipe C, contain 2·5 per cent. of acetylene. By means of the small outlet tube or pipe D, however, a gas containing from 4 to 6 per cent. or even more, depending on the width of the small outlet tube or pipe of acetylene is obtained.—*March 30th*, 1928.

288,499. October 28th, 1927.—PROCESS FOR THE MANUFACTURE OF PLATES FOR COPPER OXIDE RECTIFIERS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany, and Emil Duhme, of 52, Rohrdamm, Berlin-Siemensstadt, Germany.

This specification describes a process for the manufacture of plates for copper oxide rectifiers. The plates are introduced into a furnace the temperature of which is maintained at a given value above 1040 deg. Cent., but below the point of fusion of copper, and the time required for heating the plates to that temperature is experimentally determined. After the plates have been left in the furnace for the time thus fixed, they can be removed by means of a pair of tongs or of a hook, and immediately dipped singly or in groups into water, the plate or plates preferably turned over or the water itself being stirred or circulated about the plates. The contact of the plates with the metal of the hook or tongs and the consequent possible damage could, however, also be avoided by throwing the plates from the furnace after a certain time into the water by tilting the furnace correspondingly. It is advisable to keep the plates for a few seconds in contact with water on all sides before they drop to the bottom. This can be done either by the above-mentioned turning over, or by an artificially produced movement of the water. Neither is, however, necessary if the depth of the vessel filled with water is made such that the plates allowed to fall freely into the water, require, on account of the frictional resistance of the water, sufficiently long time—for instance, according to their thickness, two or more seconds—for reaching the bottom of the vessel. The last-mentioned method avoids an irregular cooling of the plates and the formation of undesirable stresses.—*April 12th*, 1928.

288,091. September 20th, 1927.—HYDRAULICALLY OPERATED VALVES, R. A. Blakeborough and C. Brotherton, Woodhouse Works, Brighouse, Yorks.

The aim of this invention is to provide a hydraulically operated valve which can be set at any intermediate stage of opening without any possibility of drifting, even when the piston packings on the hydraulic cylinder have become worn. Further, the speed of operation of the valve is entirely under the contol of the operator. Avoiding constructive details, which are fairly obvious in the drawing, it may be explained that if the main valve, to which the cock A is subsidiary, is stationary the pulley J and the worm wheel I will be temporarily fixed, and when the hand wheel K is turned the worm F screws its way around the periphery of the worm wheel I and thus turns the plug C of the cock A. The torque required to turn the plug will be less than the resistance of the balance weight L. When the worm F has screwed its way so far as to turn the arm E though 90 deg. the cock A will be fully open to admit fluid pressure to one side of the actuating piston of the valve and to open up the other side of the piston to exhaust. The valve will therefore



commence to move, but, in moving, the pulley J is rotated by the rope L. The worm wheel I therefore rotates also and brings back the worm F to its initial or starting position, and to produce a further movement of the valve it will be necessary to continue turning the hand wheel K. So long, therefore, as the hand wheel K is being rotated, the valve will continue to move, either in the opening or in the closing direction. As soon, however, as the operator ceases to revolve the hand wheel, then the valve will cease to move, because the cock A is constantly restored, by the movement of the valve, to its neutral or closed position. When the valve is left it will be sure to remain at the set position because any tendency to drift will cause the cock A to be opened in such a way as to oppose the drift.—*April 5th*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.—Chamber of Commerce, Room 7, Birmingham. "The Limits of Turbo-generator Design," by Mr. Wm. Sharp. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster, S.W. 1. "Notes on the Drying of Industrial Products," by Mr. A. T. Henly. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Life's Unsuspected Partnerships," by Miss Doris L. MacKinnon. 9 p.m.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.—"The Value of Aviation to the British Empire," by The Right Hon. Sir Samuel Hoare. 5.30 p.m.

SATURDAY, MAY 12TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Eastern District meeting to be held at New Malden, Surrey. 1.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Western District meeting at Totnes.

TUESDAY, MAY 15TH.

ENGINEERING GOLFING SOCIETY.—The course of the Tandridge Golf Club near Oxted. Spring meeting. 10 a.m.

INSTITUTION OF WELDING ENGINEERS.—30, Red Lion-square, W.C. 1. "Standardisation of Welding," by Mr. P. L. Roberts. 7.30 p.m.

WEDNESDAY, MAY 16TH.

FARADAY SOCIETY.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. Annual general meeting. Presidential address, "Diffusion in Solids," by Professor C. H. Desch. 8 p.m.

OVERHEAD LINES ASSOCIATION.—The Institution of Electrical Engineers. Mr. D. C. Redfern, Engineer, Lothians Electric Power Company, will open a discussion on "Standard Overhead Lines: Their Advantages and Number of Different Standards Required." 5.30 p.m.

ROYAL METAL TRADES PENSION AND BENEVOLENT SOCIETY.—Second annual golf competition at Sundridge Park Golf Club, Bromley, Kent.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, S.W. 7.—The following memoirs will be read: (1) "On Periodicity and its Existence in European Weather," Vol. 1, No. 9, by Sir Gilbert Walker; (2) "Harmonic Analysis and the Interpretation of the Results of Periodogram Investigations," Vol. 2, No. 15, by Mr. David Brunt; (3) "Periodicities in the Nile Floods," Vol. 2, No. 12, by Mr. C. E. P. Brooks. 5 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Modern Motor Car Design: Some Criticisms and Some Suggestions," by W. Worby Beaumont. 8 p.m.

SOCIETY OF TECHNICAL ENGINEERS.—102, Belgrave-road, S.W. 1. "Electricity Undertakings," Mr. G. W. Molle. 7.30 p.m.

THE OPTICAL SOCIETY.—1, Lowther-gardens, S.W. 7. "The Modern Reflecting Telescope," by Professor G. W. Ritchey. 7.30 p.m.

THURSDAY, MAY 17TH.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Hotel Metropole, Leeds. Annual general meeting. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Annual general meeting. 6 p.m.

FRIDAY, MAY 18TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, W. 1. Discourse, "The Sea in Fiction," by Mr. Morley Roberts. 9 p.m.

TUESDAY, MAY 22ND.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON).—Visit to Manchester Ship Canal. Leave Euston 8.30 a.m.

THURSDAY, MAY 24TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—East Midland District Meeting.—At Council Chamber, Council Offices, Station-road, Hinckley. 11.15 a.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ALFRED HERBERT, Ltd., of Coventry, asks us to announce that on and after May 14th, the whole of its offices and works will be concentrated at its new works, Canal-road and Cross-road, Foleshill, Coventry. Telephone, 8781; telegraphic address, Lathes, Coventry.

THE DISTRICT IRON AND STEEL COMPANY, Ltd., of Smethwick, asks us to announce that it has entered into an arrangement with the Anglo-Galvanizing Company, Ltd., of Abbey House, Victoria-street, Westminster, to adopt the latter's process of electro-galvanising, and that a plant is being erected to meet the demand for galvanising by that process for the trade in the Birmingham area.

VICKERS LTD. announces that the following have been appointed directors of the Metropolitan Carriage Wagon and Finance Company, Ltd.:—Mr. J. P. Crouch, Mr. R. C. Irwin, Mr. G. G. Sim, and Mr. Howard Williams, and that Mr. T. L. Taylor—chairman and managing director of Taylor Bros. and Co., Ltd.—and Mr. Alexander Spencer—chairman of Spencer Moulton and Co.—have been appointed chairman and vice-chairman respectively.

KORTING BROS. (1917), Ltd., of 64, Victoria-street, Westminster, London, S.W. 1, ask us to announce that they have decided to transfer the control of their business operations to their works at Mansfield, retaining the offices at the above address as a London branch only. It is requested that, in future, all communications should be addressed to Korting Bros. (1917), Ltd., engineers, Sheepbridge-lane, Mansfield. Telegrams, "Korting, Mansfield." Telephone, Mansfield 855.

MR. JOHN A. SMEETON, managing director of John A. Smeeton, Ltd., of 15, Victoria-street, London, S.W. 1, desires us to announce that his company has decided to give up, as and from May 5th, the British agency of the Demag A.G., of Duisburg, Germany, which it has held for four years. The company also wishes to disclaim all future responsibility in connection with any orders given to the Demag A.G., or for any tenders sent by it to British works, whilst it has been acting as agents on behalf of the Demag A.G.

A. RANSOME AND CO., Ltd., of Newark-on-Trent, ask us to announce that the death of Mr. Geoffrey Ransome, which occurred on April 15th last, has necessitated certain alterations in their organisation. Mr. F. W. Baker, who has been associated with the company for over forty years, has been elected chairman, the other directors being Mr. E. Edis, who is also secretary; Mr. R. H. Bradley, who is also works manager; Colonel John Josselyn; and, in addition, Mr. Kenneth McLean, sales and commercial manager, who has recently been elected.

THE INSTITUTION OF CIVIL ENGINEERS.—The Council of the Institution of Civil Engineers has recently made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1927–1928.—Telford Gold Medals to Dr. Oscar Faber, M. Inst. C.E. (London), and Mr. G. L. Watson, M. Inst. C.E. (Newark, New Jersey); Telford Premiums to Professor John Goodman, M. Inst. C.E. (Skipton), Mr. James Williamson, M. Inst. C.E. (Wallington), Mr. R. M. Wynne-Edwards, D.S.O., Assoc. M. Inst. C.E. (Vancouver), and jointly to Mr. F. C. Vokes, Assoc. M. Inst. C.E. (Birmingham, and Mr. C. B. Townend, Assoc. M. Inst. C.E. (Birmingham).

THE INSTITUTION OF GAS ENGINEERS.—We are asked by Mr. Walter T. Dunn, the secretary of the Institution of Gas Engineers, to state that the last meeting of the Council—before the annual meeting at Cardiff—at which applications for membership will be considered by the Council, takes place in London on May 21st. The names of candidates then approved will be included in the ballot list which is to be issued on May 24th. Candidates after that date will be required to enter the Institution by examination only or under the exempting or qualifying clauses of the by-laws of the Royal Charter, the petition of which has been duly completed and deposited with H.M. Privy Council for its consideration.

STONE PATTERNS.—A sample of work carried out in "Titanite," which is intended primarily for making casting patterns, has been sent to us by the Constructional Engineering Company, Ltd., of Charles Henry-street, Birmingham. This sample, which has all the appearance of being a cast in very fine Portland cement, has sharp angles and is obviously strong—for we have deliberately tried to destroy it by throwing it on the floor. These casts are made in an ordinary sand mould, rammed rather hard and surfaced with a special form of insulating solution. The cast, it is said, will be hard and ready for service in from six to eight hours, and will provide as many as 40,000 moulds from one pattern plate before it is worn out.

THE INSTITUTE OF METALS.—The Council of the Institute of Metals has just issued a preliminary programme of the four-day annual autumn meeting of the Institute, which is to be held this year in Liverpool. The proceedings will begin on September 4th with a lecture on "Non-ferrous Metals in the Shipping Industry," by Mr. F. G. Martin. The mornings of September 5th and 6th will be devoted to the reading and discussion of papers and the afternoons to visiting works of interest in the neighbourhood, the Gladstone Dock and a large liner. In the evening of September 6th there will be a reception at the Town Hall by the Lord Mayor (Miss Margaret Beavan). The meeting will conclude on September 7th with an all-day motor trip to North Wales, during the course of which it is expected that an electric power station and aluminium works will be visited. Further particulars of the meeting can be obtained from the Honorary Local Secretary, Mr. H. F. Richards, B.Sc., 42, Bedford-street, Liverpool, or from the Secretary of the Institute of Metals, Mr. G. Shaw Scott, M.Sc., 36, Victoria-street, London, S.W. 1.